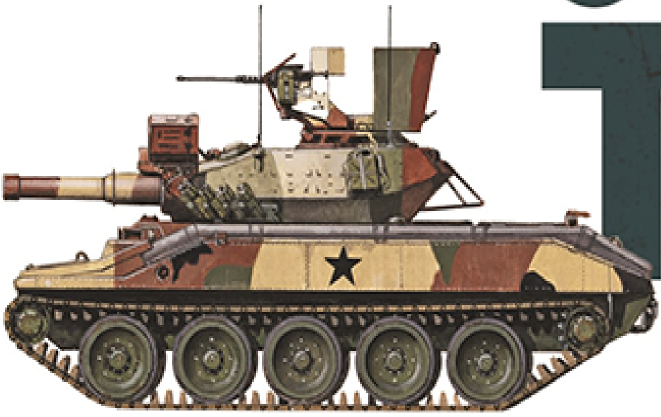

US BATTLE TANKS

1946–2025

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INTRODUCTION

This book is the second part of a history of the development and combat use of US tanks since 1915. The previous book covered the period from 1917 to the end of World War II in 1945. This book continues the story, covering the almost 80 years from 1946 to 2025. The principal focus of this volume is the main battle tank, formerly called the medium tank. Light and heavy tanks largely disappeared in the 1960s, though efforts to develop tanks for the mechanized cavalry and expeditionary tank roles have continued. This book does not consider specialized anti-armor vehicles reliant on anti-tank missiles as their principal armament since these have generally been based on light trucks or variants of armored infantry transporters.

A brief explanation is worthwhile about the confusing evolution of the names of the Army organizations responsible for US tank development. These various acronyms, such as OCO-D, OTAC, ATAC, and TACOM, turn up regularly in this book. Although there have been many names, nearly all of these organizations have been based at the Detroit Arsenal in Warren, Michigan. US tank development in World War II was undertaken by the Office Chief of Ordnance, Detroit (OCO-D), located at the Detroit Tank Arsenal. It was part of a larger Army network of development and testing centers including Aberdeen Proving Ground in Maryland. On October 24, 1950, OCO-D was renamed as the Ordnance Tank-Automotive Center (OTAC), still located at the Detroit Arsenal.

Army tank development in the 1960s underwent a confusing bureaucratic shuffle, though with a brief exception, it remained headquartered at the Detroit Arsenal. In December 1962, OTAC was renamed the Army Tank-Automotive Center (ATAC) and placed under the new US Army Materiel Command. This severed the four-decade link between US Army tank development and the Ordnance branch. The Army's armored combat vehicle programs were transferred from the Detroit Arsenal to the new Weapons Command (WECOM) at Rock

Island Arsenal, Illinois. Rock Island Arsenal had led US Army tank development in the 1920s and 1930s. The return of Rock Island to the tank development business was very short-lived. In 1967, ATAC was renamed again as the US Army Tank-Automotive Command (TACOM). Responsibility for armored personnel carriers was shifted back from WECOM to TACOM in January 1967, and tank development returned in June 1972. Army tank development has remained in Warren, Michigan, since then, though there have been numerous permutations of the names of associated agencies.

CHAPTER ONE
THE WARTIME LEGACY

From 1940 to 1945, the United States produced 89,635 tanks plus a further 9,400 tank destroyers. Of these, 37,323 tanks and 2,830 tank destroyers were delivered to Allied armies through the Lend-Lease program, about 40 percent of the total production. With the end of the war in sight, the US Army began winding down tank production in late 1944 and canceling remaining portions of most contracts. Manufacture of the M4 Sherman medium tank ended in July 1945 and production of the new M26 Pershing in October 1945. Manufacture of several new types of heavy tanks was canceled before any serial production occurred.

In May 1945, the US Army in the European theater had about 11,100 tanks deployed with combat units and additional tanks in theater reserve. Counting tanks in the Mediterranean and Pacific as well as in the United States, the overall total inventory was 28,648 tanks as detailed in the accompanying chart. This was roughly half of the tanks manufactured for the US Army from 1940 to 1945. The remainder of the production, excluding Lend-Lease, consisted of combat losses and older tanks. The United States suffered losses of 7,937 tanks during World War II, including 277 in the North African theater, 763 in the Italian theater, 6,085 in the European theater, and 812 in the Pacific theater. Many of the tanks manufactured early in the war, including the M2A4 and M3 light tanks as well as the M3 medium tank, had been declared obsolete and some had already been scrapped.

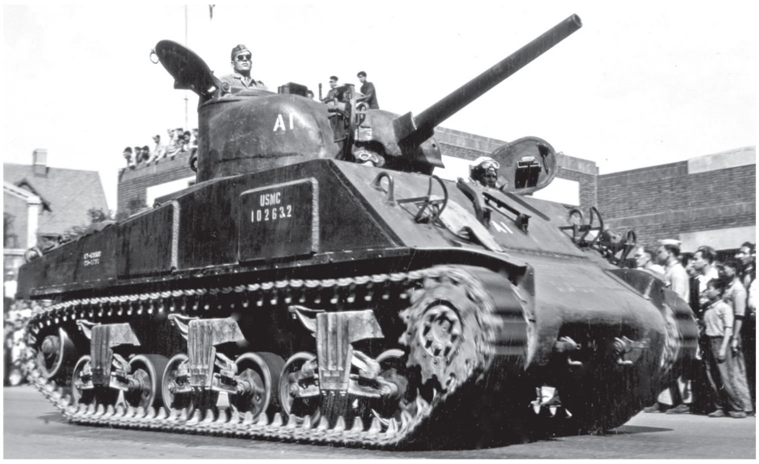
While the M26 Pershing arrived too late to have much impact on the fighting in the European Theater of Operations, it became the backbone of the US armored force in the years after the war. In a scene reminiscent of World War II, a column of M26 Pershing tanks of 3/2nd Armored Cavalry advances under the cover of a P-47 Thunderbolt of the 86th Fighter Wing during exercises near Eberbach, Germany, on April 21, 1949.

US Army post-war tank inventory, December 31, 1945

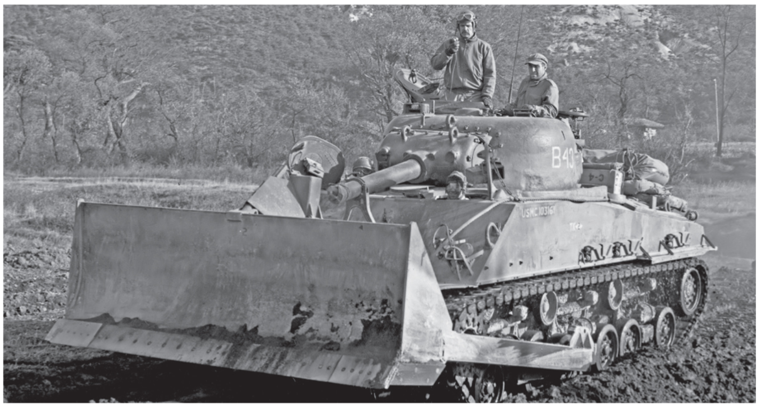
M22, M5A1 light tank	4,337
M24 light tank	4,962
M4 (75mm) medium tank	6,933
M4 (76mm) medium tank	6,582
M4 (105mm) howitzer tank	3,731
M26 medium tank	1,918
M45 (105mm) howitzer tank	185
Total	28,648

Of the tanks still in inventory, many were designated as “limited standard,” meaning outdated but usable if necessary. Most of these were either transferred to Allied armies, or gradually scrapped. The M22 light tank was obsolete and scrapped. The US Army favored the new M24 as its basic light tank, and so the M5A1 light tank was withdrawn from US Army service. The M4 Sherman remained the most numerous medium tank, with 17,246 still in service. With the exception of small numbers in the National Guard, Marines, or in war reserves, the 75mm versions of the Sherman disappeared from US Army service; most were handed off to Allied armies.

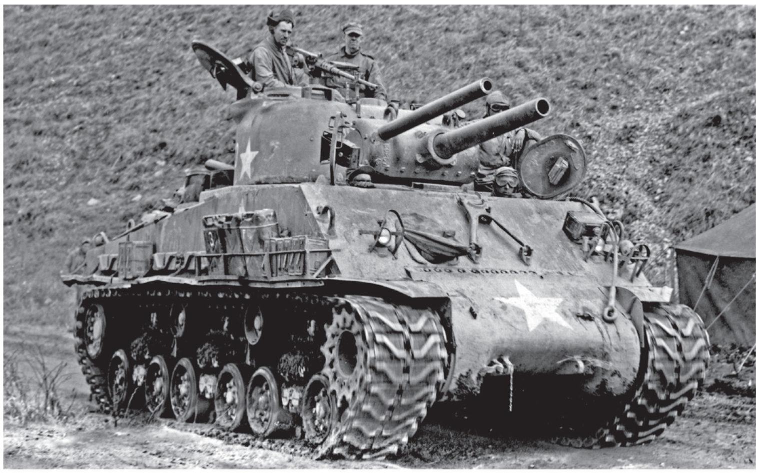
The War Department Equipment Board, headed by Gen. Joseph Stilwell, issued its report in January 1946 that recommended that the Army initiate a five-year program to develop new light, medium, and heavy tanks. By this stage, the Army concluded that the separate tank destroyer category was no longer valid, and so development and deployment of tank destroyers ended. The Stilwell program was not well funded and the results were very uneven.



The Marines retained the older Sherman tanks with 75mm gun through the late 1940s. This Marine M4A2 of Co. A, 1st Tank Battalion, is seen on parade in Tientsin (Tianjin), China, in May 1946 while part of the III Amphibious Corps' Operation *Beleaguer* to supervise the repatriation of Japanese troops.



The M4A3 (105mm) assault gun formed the backbone of the Marine Corps tank battalions after World War II, constituting about half of the inventory. This example, fitted with an M1 dozer blade, is seen here on November 10, 1950 near Wonsan, South Korea.



The Marine Corps retained Sherman flamethrower tanks after World War II. This is an M4A3 (105mm) assault gun with the co-axial POA-CWS H5 co-axial flamethrower of the "Flame Dragons," Flame Platoon, 1st Marine Tank Battalion, near Hongchon, Korea, on March 17, 1951.

THE START OF THE COLD WAR

Tensions in Europe between the Soviet Union and the Western Allies began to fester in the final year of World War II due to Stalin's plans to forcefully Sovietize the countries of east central Europe. In March 1946, Winston Churchill delivered his famous "Sinews of Peace" speech at Westminster College in Fulton, Missouri, in which he remarked that

"From Stettin in the Baltic to Trieste in the Adriatic, an iron curtain has descended across the Continent."

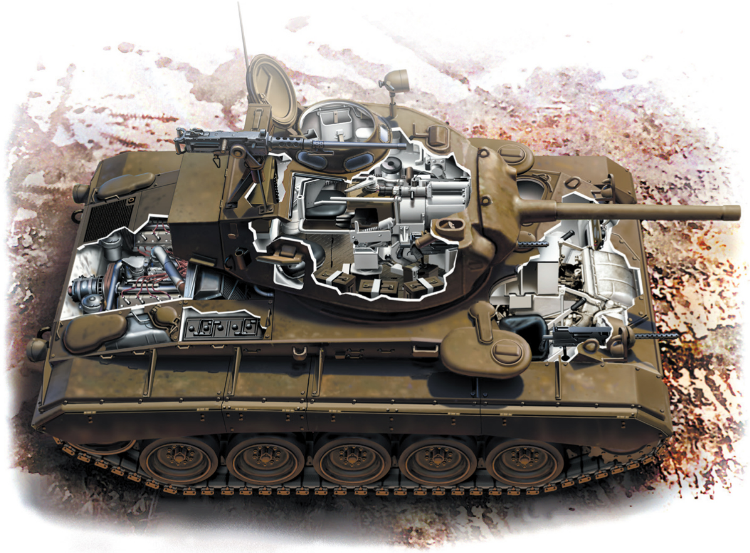
The most substantial American armored force in occupied Germany in the late 1940s were the three US Constabulary brigades, a type of military police force. This is an M24 of the 14th Constabulary Regiment on parade in Frankfurt. These units also had M8 armored cars and M26 medium tanks.

M26 tanks of the Tank Company, 6th Infantry Regiment, pass in review in Berlin on October 17, 1951. The regiment had been reactivated a year before by reorganizing disbanded Constabulary units.

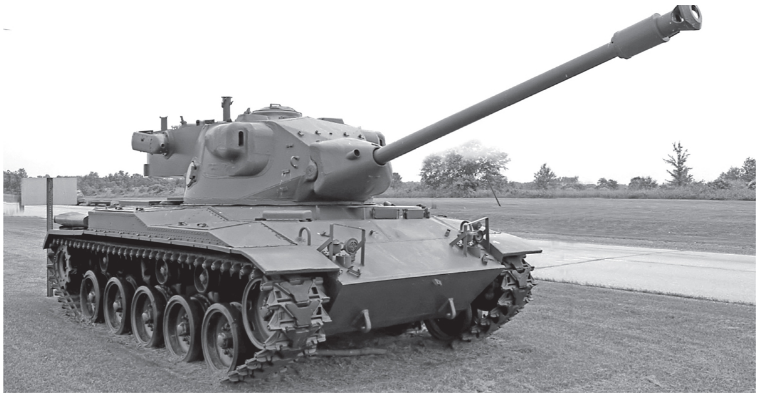
The first years of the Cold War saw little military modernization on either side of the Iron Curtain due to general war exhaustion in Europe. The Communist takeover of Czechoslovakia in February 1948 marked the end of political autonomy in the Soviet-occupied region. In response to the growing political tensions, in 1949 the North Atlantic Treaty Organization (NATO) was formed as a mutual defense agreement against further Soviet expansionism in Europe. The economies of the NATO countries were still suffering from the devastation of war, and so in October 1949, the US Congress authorized the Mutual Defense Assistance Program (MDAP), which allocated $1.4 billion to help rebuild Western European defenses. As a result, the NATO armies, except for Britain, were primarily equipped with American tanks through the 1950s.

POST-WAR LIGHT TANKS

In the wake of World War II, the US Army convened a General Board to evaluate the lessons from the conflict and propose changes to equipment and organization. During the war, tank battalions consisted of three companies of medium tanks and one company of light tanks. There was an overwhelming consensus that the light tanks were inappropriate in the tank battalions due to their light armor and limited firepower. Consequently, the Army finally decided to remove light tank companies from the tank battalions, which would now be composed entirely of medium tanks. Instead, each armored division would have a reconnaissance battalion with 30 light tanks. A further 28 light tanks were dispersed among divisional units, three to each combat command for reconnaissance, and two to each tank battalion and armored infantry battalion. These plans did not take effect until 1952 and were not universal in the battalions fighting in Korea.



M24 light tank, 1944. (Artwork by Jim Laurier © Osprey Publishing)



The T37 was the original configuration for the Army's new light tank program. It had a number of curious features, including anti-aircraft machine-gun barbettes on the rear turret bustle. The turret was significantly redesigned before it emerged as the M41 76mm gun tank. (Author)

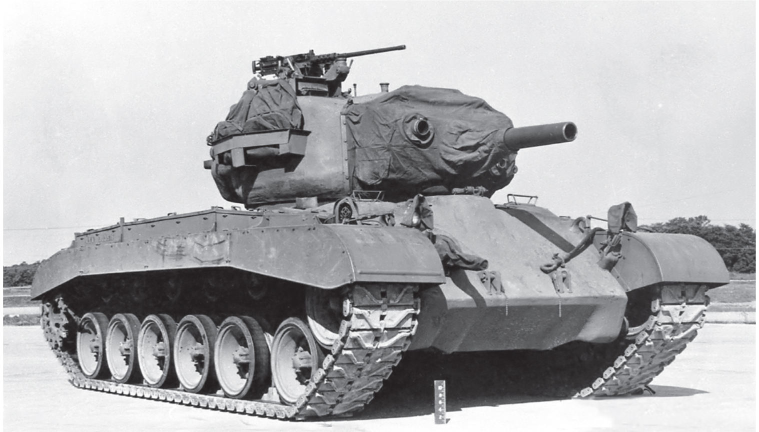
Besides their use in light tank companies, the light tanks of World War II had been used in mechanized cavalry units. Although ostensibly designed for reconnaissance, post-war studies found that in 1942–45 such units were used in defensive combat 33 percent of the time; on special operations such as mobile reserve or rear-area clean-up, 29 percent of the time; on security duty such as flank protection, 25 percent of the time; on offensive operations, 10 percent of the time; and on scouting, only 3 percent of the time. This had serious implications for light tank design, implying that the light tank should be armed with a gun sufficient to defeat the enemy armor. The existing M24 was not capable of mounting a much more powerful weapon, so a complete redesign was required. Although the new tank was not to be significantly different from the M24 in armor or mobility, it would have enhanced firepower, capable of defeating the baseline threat which in the late 1940s was the Soviet T-34-85 medium tank.

The development of a new light tank was initiated in July 1946 as the T37. Compared to the M24 light tank, the principal differences were a new 76mm gun and a new powertrain. The long 76mm gun was intended to give the T37 better anti-tank performance compared to the short 75mm gun on the M24 Chaffee. The requirement was to be able to penetrate 5 inches (127mm) of armor at 30 degrees at 1,000 yards. The first pilot was delivered for testing in May 1949 but was not ready for production when the Korean War broke out in the summer of 1950. It would eventually emerge as the M41 light tank in 1951 as detailed from here.

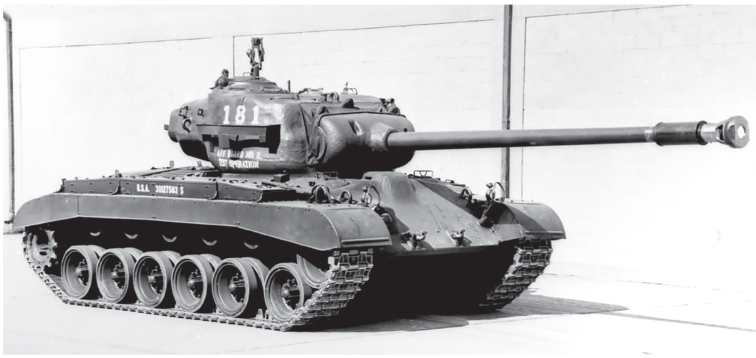
POST-WAR MEDIUM TANKS

The M26 Pershing tank had entered combat only in February 1945, so there was no pressure to rush a replacement into production. Wartime plans had called for 6,000 M26s to be built, but in the end, production halted in October 1945 at 2,212 tanks. In terms of cost, the price of a T26E3 was $83,273 compared to $69,288 for an M4A1 (76mm) Sherman tank. During the war, the M26 had been classified as a heavy tank, but in May 1946, it was reclassified as a medium tank due to the changing conception of US Army tank needs as well as programs to develop much heavier tanks for the future. Several variants of the M26 were under development in the final months of war, and these programs continued.

Since 1944, there had been a requirement for an assault gun version of the M26, armed with a 105mm howitzer instead of the usual 90mm tank gun. This was intended to be used in the headquarters companies of the T26E3 battalions along the same lines as the M4 105mm assault guns, for indirect fire support for the tank battalions. This version had the experimental designation of T26E2 howitzer tank. The program did not have high priority, and the pilot was delivered for trials only in July 1945. After service acceptance, it was designated as M45. Due to the lighter weight of the M4 105mm howitzer compared to the M3 90mm gun, the M45 tank had a thicker gun mantlet than the normal M26 tank, fully 8 inches (200mm) thick, to balance the weight of the turret. With the war in Europe ending, production requirements dropped precipitously, and only 185 M45 105mm tanks were completed starting in July 1945.



The M45 105mm assault gun was a derivative of the M26 Pershing, armed with a short 105mm howitzer to provide indirect fire support for tank battalions. It was built in small numbers before production ceased after the war.



The M26E1 was fitted with the improved T54 90mm gun with a new muzzle brake and bore evacuator. This led to the upgraded M26A1 and eventually the M46 tank.

Work also continued on versions of the T26 armed with more powerful guns. This effort was undertaken mainly to deal with the threat of German heavy tanks such as the Tiger II. The T26E1 "Super Pershing" had been fitted with the experimental T15 90mm gun as an expedient. In 1945, work shifted to the T26E4, using the T15E2 gun in an improved mount that did not require the improvised recuperator springs awkwardly located externally on the turret roof. The main problem with this tank was that the gun used a two-piece, split ammunition with separate projectile and propellant casing which reduced the rate of fire of the weapon. Although there had been plans to build 1,000 of these in place of the normal M26, the end of the war led to this matter being reconsidered. A total of only 25 of these tanks were completed in 1945. Work shifted to the new T54 90mm gun that had the ballistic characteristics of the earlier weapon, but introduced a one-piece round that would be easier to handle inside the turret. Further work on this design was undertaken after the war on an M26E1 pilot that introduced further improvements inside the turret such as a concentric recoil mechanism to take up less internal space. Firing trials of the M26E1 were conducted at Aberdeen Proving Ground from February 1947 to January 1949 and led to the conclusion that the gun offered superior performance to any other tank gun then in service. Another weapon tested on the M26E1 was the 3-inch T98, a hypervelocity cannon based on the Navy's 3-inch gun.

Due to the restricted budgets of the immediate post-war years and the lack of any pressing requirement for such a powerful weapon, the improved 90mm gun tank program slipped into limbo. In December 1946, the pilot tanks were put into storage as a war reserve item to be used to supplement the M26 Pershing tank in the event of an emergency. In fact, they were never taken out of war reserve, even during the Korean War.

The final version of the M26 produced during the war was the T26E5, an attempt to manufacture an assault tank comparable to the heavily armored M4A3E2 of the Sherman tank family. This increased the thickness of the hull front to 152mm and 190mm on the turret front. A total of 27 of these were built starting in June 1945, and they were used only for test purposes after the war. The project was revived in modified form in August 1945 as the T32 heavy tank, but only two pilots were built.

The only new medium tank to emerge prior to the Korean War was the M46. This began in January 1948 as the M26E2 and was intended to adapt new features into the M26 tank, including the Continental AV-1790-3 engine. The main problem with the M26 was that it used the same engine as the M4A3 medium tank but was significantly heavier. As a result, it had poorer mobility. The new engine boosted horsepower from 500hp to 810hp, and was teamed with a new Allison CD-850-1 cross-drive transmission. Both new elements took up no more space or weight than the earlier components yet offered a substantial increase in power. These innovations would form the basis of the powertrain in all US medium tanks and main battle tanks through the M60A3 in the 1980s.

The first modified M26 in the M26E2 configuration was delivered for trials to Aberdeen Proving Ground in May 1948. The trials revealed the usual number of technical problems. Although there were plans to incorporate the more powerful T54 long 90mm gun into the design, there was resistance in the Army to introducing new and heavier ammunition when there was no threat perceived as significant enough to warrant such a weapon. Instead, the M3 90mm gun was improved as the M3A1 by the use of a new bore evacuator to reduce the fumes in the turret from firing the gun. It was also fitted with a new muzzle brake to reduce recoil forces. These changes and the other automotive improvements led Ordnance to re-designate the new pilot as the T40.

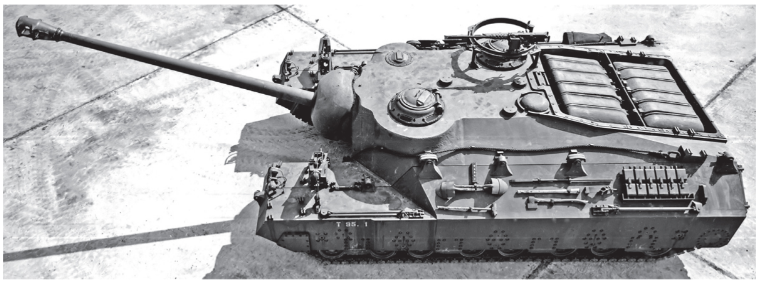
The T40 program was accelerated by the Cold War as relations between the United States and the Soviet Union continued to deteriorate. A total of ten T40 pilots were funded in 1948, and engineering tests began in August 1949. Although the Army wanted a wholly new tank design, this would take time. Instead, the T40 was accepted as the basis for an interim tank that could be fielded by remanufacturing the existing M26. The modernized M26E2/T40 was different enough from the M26 that it was redesignated as the M46, and it was later renamed the "General Patton" in honor of Gen. George S. Patton, Jr.

The trials went smoothly, and initial funding was provided in the 1949 budget. This covered 800 tanks, leaving 1,215 additional tanks in inventory suitable for upgrade. The first production M46 tanks arrived at Aberdeen Proving Ground in November 1949 for trials. By the time of the outbreak of the Korean War, 319 M46 Patton tanks had been upgraded. Ultimately, the Korean War interfered with plans to rebuild additional M26s since tanks were needed so desperately in Korea. However, a more modest improvement program was already underway that substituted the M3A1 gun of the M46 for the older M3 gun. M26 tanks rebuilt with this feature were redesignated as M26A1.

In December 1948, the Army began development of a new medium tank, the T42. The hull of the new design was somewhat shorter than that of the M26, but the principal change was in the turret. The new turret casting emphasized ballistic shaping to improve the tank's protection, with a very narrow gun mantlet compared to that of the M26 Pershing. The most important innovation in the T42 tank's firepower was the use of a new optical rangefinder to improve long-range accuracy. This was part of a broader program to introduce optical rangefinders in all new Army tanks, including the T37 light tank and T43 heavy tank. The T42 tank was not ready at the outbreak of the Korean War, and the first pilot did not arrive at Aberdeen Proving Ground until December 1950.

POST-WAR HEAVY TANKS

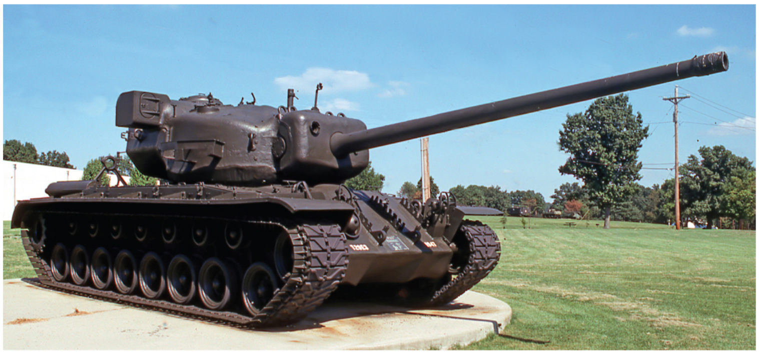
Through most of 1944, there was little demand in the US Army for a heavy tank to challenge the Tiger. The Army resisted the adoption of heavy tanks if for no other reason than the difficulty of transporting them from the United States to faraway combat theaters, and the difficulties of operating them in many areas of Europe and the Pacific.



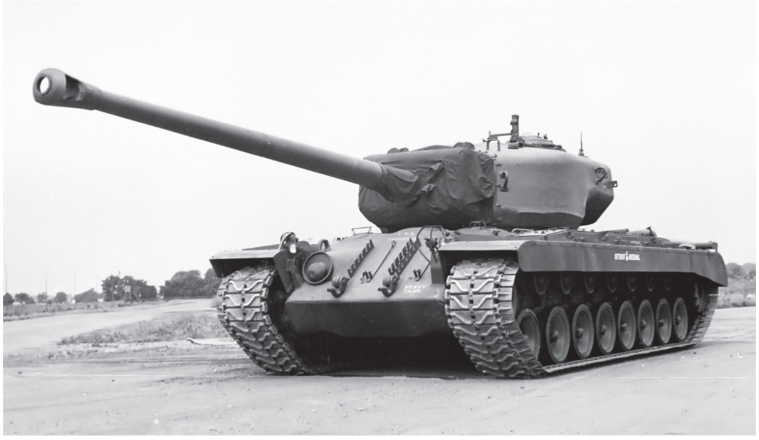
The T95 105mm gun motor carriage, redesignated in June 1946 as the T28 Super Heavy Tank, was one of the most unusual US tank designs of the war years. It was intended as an assault tank to challenge the Siegfried Line but was not ready until after the war. Two were built, but it was too heavy to be practical.

Work had begun in 1943 on the T28 heavy tank, but this was intended primarily as a thickly armored assault vehicle, capable of attacking German fortified defenses such as the Siegfried Line. It was armed with the 105mm T5E1 gun and used the same powertrain as the M26 tank. Frontal armor was an impressive 12 inches (305mm), enough to defend the tank against the vaunted German 88mm gun. Due to the thick armor and heavy gun, the T28 did not use a conventional layout but instead had the gun mounted in a fixed casemate with 10 degrees' traverse to either side. Due to its colossal 95-ton combat-loaded weight, its suspension was equally unusual, consisting of two parallel sets of tracks on either side employing the same horizontal volute suspension system (HVSS) bogies as the M4A3E8 tank. The outer suspension set could be removed to reduce the tank's width for transport. Due to the unusual configuration, the T28 was reclassified as the T95 105mm gun motor carriage in April 1945.

Plans to quickly build five examples in time for wartime deployment were scaled down to only two pilots due to the engineering challenges of the design. The first frontal armor casting was not completed until June 1945, and the first pilot arrived at Aberdeen Proving Ground (APG) in December 1945 to start tests. The second pilot was shipped to Fort Knox and subsequently to the Yuma Proving Ground. This vehicle was redesignated yet again in June 1946 as the T28 Super Heavy Tank. The APG report of October 1947 recommended that further development of the T28 be terminated since the T29 heavy tank, also armed with a 105mm gun, had proven satisfactory without all the drawbacks of the T28's weight and unusual configuration.



The T29 heavy tank was armed with a new 105mm tank gun. The T29E2 seen here at the Patton Museum at Fort Knox in the 1970s was fitted with a large coincidence rangefinder, evident on the side of the turret. (Author)



The T30 heavy tank was armed with the T7 155mm gun, the largest-caliber tank gun ever deployed on an American tank. Development work on the T30 petered out in the late 1940s due to lack of funding.

Aside from the bizarre T28 heavy tank, the US Army was also examining heavy tanks derived from the M26 Pershing but armed with more powerful guns and thicker armor. Development of the T29 and T30 heavy tanks began in September 1944. Although the lineage of the T29 and T30 was clearly linked to the M26 Pershing, many aspects were significantly different from the M26 tank. The chassis was lengthened to accommodate the extra weight of the larger turret, a more powerful engine was introduced, and the turrets were considerably larger. The T29 mounted a T5E1 105mm long-barreled gun, and the T30 was armed with a T7 155mm gun. A third type was introduced in April 1945, the T34, armed with a T53 120mm gun.

After contact with the German Tiger II heavy tank in the Ardennes in December 1944, Army interest in fielding these heavy tanks increased considerably. Procurement of 1,152 T29 heavy tanks was approved on April 12, 1945. However, when the war ended in August 1945, the production contracts were canceled. Instead, production of ten T29 pilots was authorized on August 23, 1945 for further experimental work. These varied in configuration to examine alternative sub-components. For example, the first pilot was modified with an Allison V-12 aircraft engine, and the second pilot was fitted with a gun stabilization system.

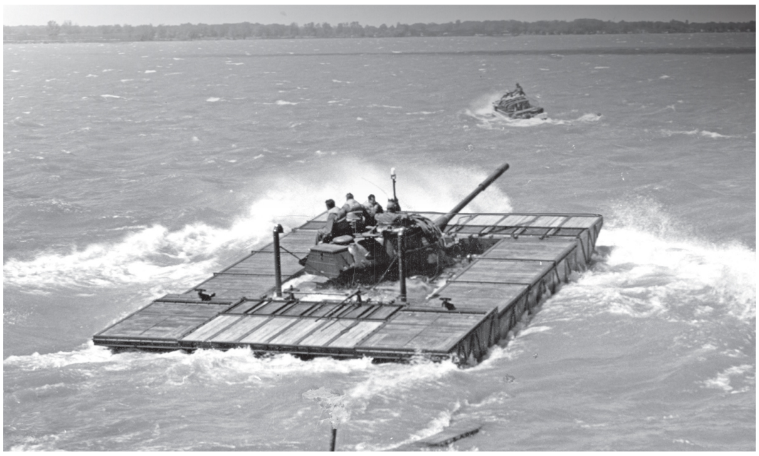
The T30 heavy tank was armed with the largest gun fitted to a US tank, the T7 155mm gun. Twelve pilots were authorized, but in November 1946, two were diverted to the T34 heavy tank program. This was in no small measure due to the recognition that a 155mm gun was excessive, and that a tank gun based on the existing 120mm anti-aircraft gun was adequate to deal with the most likely threats. These three heavy tanks remained in development and testing until the late 1940s.

The heavy tank programs were reinvigorated by the increasing international tensions with the Soviet Union. The Red Army had first paraded its new IS-3 heavy tank with 122mm gun in Berlin in September 1945. The IS-3 had well-sloped armor and became the new nightmare for American tank designers, superseding the German Tiger II threat.

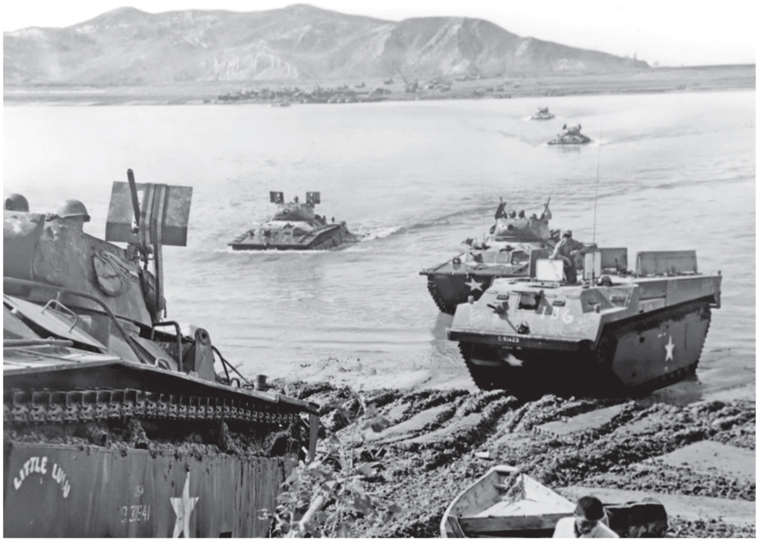
In December 1948, the US Army started a new heavy tank as a clean slate, not relying on the wartime features found on the T29, T30, and T34. The new T43 heavy tank placed greater emphasis on sloped armor and improved firepower. The T43 was armed with the new T123E1 120mm gun. One of the most important innovations in the design was the use of an optical rangefinder that promised to offer much better accuracy at long range. The enlarged turret made it easier to service the new gun, but at the same time, it was better sloped than the wartime designs. It was not ready at the time of the outbreak of the Korean War, and the first pilot did not arrive for testing at Aberdeen Proving Ground until June 1951. It eventually emerged after the Korean War as the M103 as is described from here.

POST-WAR AMPHIBIOUS TANKS

Both the US Army and US Marine Corps used amphibious tanks in World War II, especially in the Pacific theater. Three configurations were used: deep-wading tanks, tanks with floatation devices, and amphibious tanks derived from amphibious tractors (amtracs).



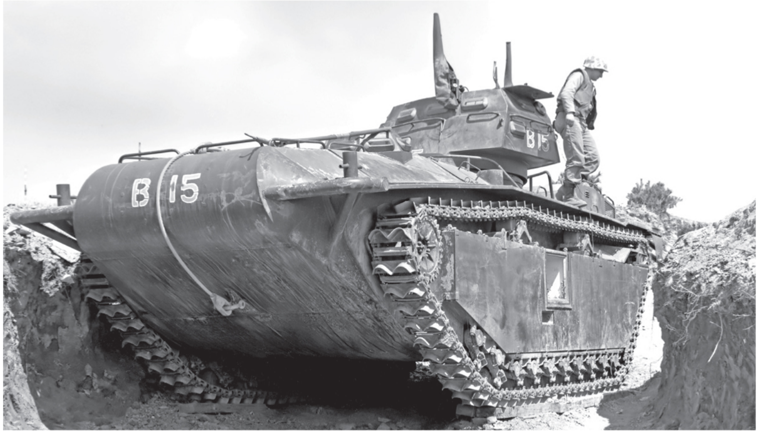
The Marine Corps retained an interest in adaptor kits to permit tanks to swim ashore during amphibious operations. This is an M47 tank fitted with the T15 floatation device during a floatation test on Lake St. Clair at Selfridge Field near Detroit on June 3, 1953.



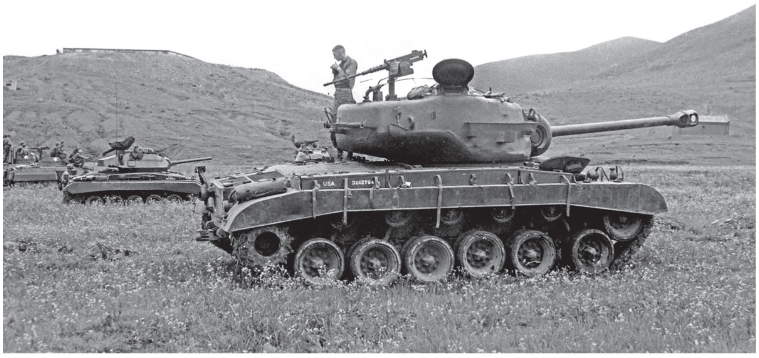
Amtanks support the crossing of the Han river by the 1st Marine Division on September 21, 1950. These are LVT(A)5s with an LVT-3C troop carrier evident in the center right.

Deep-wading tanks were ordinary tanks that were waterproofed to prevent water from entering the hull and short-circuiting the electrical systems. These tanks were usually fitted with a deep-wading trunk that provided air to the crew and engine. A deep-wading tank could be dropped off from a landing craft in water up to its turret, and then advance to shore with its tracks resting on the seabed. This configuration remained in use after the war, with deep-wading kits prepared for most major tank types.

Floatation devices consisted of systems to permit tanks to float on the surface. Two types predominated: folding skirts and detachable pontoons. The best known of the skirt configuration was the M4A1 Duplex Drive Sherman tank as used on D-Day in Normandy. This configuration largely fell out of favor after World War II since the skirt could be easily damaged in rough seas. It did remain in use on lighter vehicles for river crossings, as will be described later in this book with regard to the M551 Sheridan. Detachable pontoons appeared only in the final year of the war, such as the T7 floatation device for the Sherman tank in the Okinawa campaign in 1945. This consisted of a set a pontoons attached to the tank hull that offered enough buoyancy to keep the tank afloat. There were numerous trials of this configuration in the late 1940s and early 1950s, but none was adopted for serial production.



The LVT(A)5 Modified was easily distinguishable by its bulbous nose fairing, added to make the amtank more buoyant in water. A cover was also added over the turret during this upgrade. An LVT(A)5 Modified is seen here with the 1st Armored Amphibian and Tractor Battalion defending the perimeter at Kimpo airfield in Korea on April 9, 1953.



The first Pershing tanks to see combat in Korea were found in Tokyo depots and hastily shipped to Korea. They were used to form a provisional tank company, but in their first engagement at Chinju against the NKPA 6th Infantry Division on July 28, 1950, all were lost due to mechanical breakdowns. This photo was taken of the unit during training at Taegu on July 20, 1950, and there is an M24 Chaffee and an M8 armored car in the background.

Amtanks were turreted versions of amtracs. The best known of the World War II examples were the LVT(A)1 armed with a 37mm gun and the LVT(A)4 with a 75mm howitzer. These amtanks were formed into amphibious tank battalions to provide fire support at the start of amphibious operations. Following World War II, the US Army abandoned amphibious tank battalions, leaving this specialized task to the Marine Corps.

The Marine Corps retained the LVT(A)4 in service after World War II. A number of upgrades for the LVT(A)4 had been planned during the war, including power traverse for the turret, a vertical stabilizer for the 75mm howitzer, and an additional generator for the added systems. This upgraded LVT(A)4 was designated as the LVT(A)5, and 269 were manufactured in 1945. Other upgrades were considered, such as the substitution of an M24 light tank turret for the type in use on the LVT(A)4. These programs did not survive the blanket cancelation of many projects at the end of the war. In 1949, the Marine Corps still had 14 LVT(A)4s and 189 LVT(A)5s on hand.

The LVT(A)4 and LVT(A)5 had mediocre performance in the water due to marginal buoyancy when combat loaded. In 1949, the Marine Corps, working with the Navy's Bureau of Ships, funded FMC Corporation to develop an upgrade kit to provide the LVT(A)5 with better sea-handling characteristics. This was done by adding an additional fairing on the hull to improve the buoyancy. A raised turret cover was also added to offer the gun crew better protection. The upgrade program was undertaken by the Long Beach Navy Yard starting in 1948. This was accepted for service as the LVT(A)5 Modified. The LVT(A)5 saw combat during the Korean War with the 56th Amphibian Tank and Tractor Battalion during the Inchon landings.

The Marine Corps also funded a number of experimental amphibious tractors/tanks in the late 1940s, but none entered production due to a shortage of funding.

ON THE EVE OF ANOTHER WAR

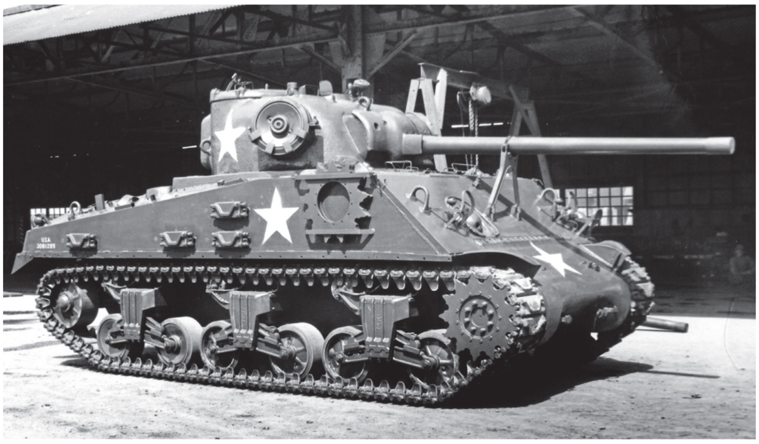
The US Army experienced a severe drawdown of its deployed tank forces after the end of World War II. Major armored forces deployed overseas amounted to only three US Constabulary brigades and a divisional tank battalion in occupied Germany and four tank companies attached to the occupation divisions in Japan. After reaching a low point in 1947, the worsening international situation with the Soviet Union encouraged Washington to halt the decline and to begin a gradual rebuilding of Army strength. This eventually included the conversion of the three Constabulary brigades in Germany into armored cavalry regiments. On paper, each infantry division was supposed to have an organic tank battalion; this had not been completed by 1950 when the Korean War broke out.

By 1948, the US Army's tank inventory had become so decrepit from lack of maintenance that only 1,762 tanks were considered fit for field use. In July 1948, the US Army initiated a program to rebuild all economically repairable tanks by the end of 1951, either for future US use or for transfer to allied armies. In 1949, the Army initiated a Balanced Tank Program that planned to cut the inventory by more than half by 1950, some of the tanks being transferred as foreign aid, and others converted to recovery vehicles. This is detailed in the accompanying chart. When tensions began rising in 1950, the US Army in Europe (USAREUR) redeployed several divisions to the Seventh Army in Germany.

By the summer of 1951, V Corps had 687 tanks and VII Corps had 312. At this time, the Army's principal tanks were the M26 Pershing and the M4A3E8 Sherman. In November 1950, the US Army dropped the previous distinction of light, medium, and heavy tanks and instead referred to them by their gun caliber – so, "90mm gun tank M46A1."

Aside from its tank requirements for the Korean War, the US was also rebuilding numerous allied armies. With few 76mm gun Sherman tanks remaining for export, the US Army decided to initiate a program to modernize about a thousand M4A1 and M4A3 75mm gun tanks with 76mm guns and other improvements specifically for the MDAP recipients. This program was conducted mainly by Bowen & McLaughlin York (BMY) in York, Pennsylvania, and Rock Island Arsenal in Illinois, and the refurbished tanks were designated as M4A1E4 (76mm) and M4A3E4 (76mm). Many of these vehicles had the spaced-out vertical volute suspension which permitted extended end connectors to be fitted both inboard and outboard of the track. The

M4E4 (76mm) was supplied to a number of MDAP recipients, including Yugoslavia, Denmark, Pakistan, and Portugal. Pakistan was by far the largest recipient, with 547 tanks. These later took part in a number of the wars with India, most notably in 1965.



Ordnance rearmed some older M4A3 Shermans after World War II with the M1 76mm gun. These M4A1E4 (76mm) were primarily intended for transfer to allied armies under the MDAP. This example was converted at the Tokyo Ordnance Depot in September 1950 during the Korean tank crisis.

US Army post-war tank inventory, 1945–50

	1949 Zone of the Interior	1949 Overseas	1949 Total	1950 Plan
M22, M5A1 light tank	964	0	964	0
M24 light tank	3,379	454	3,833	3,833
M4 (75mm) medium tank	5,455	156	5,611	0
M4 (76mm) medium tank	5,635	65	5,700	3,688
M4 (105mm) howitzer tank	2,886	97	2,983	0
M26 medium tank	1,523	378	1,901	0
M45 (105mm) howitzer tank	183	0	183	183
M46 medium tank	18	0	18	810
Other 90mm tank	49	0	49	47

Flamethrower, other tanks	151	0	151	149
Total	20,243	1,150	21,393	8,710

US Marine Corps tank inventory, 1949

	Serviceable	Unserviceable	Total
M4A3 (75mm)	16	133	149
M4A3 (75mm with flamethrower)	4	1	5
M4A3 (105mm, manual traverse)	33	7	40
M4A3 (105mm, power traverse)	176	9	185
M4A3 (105mm with flamethrower)	7	27	34
M26	99	3	102
Total	335	180	515

CHAPTER TWO
TANK WAR IN KOREA

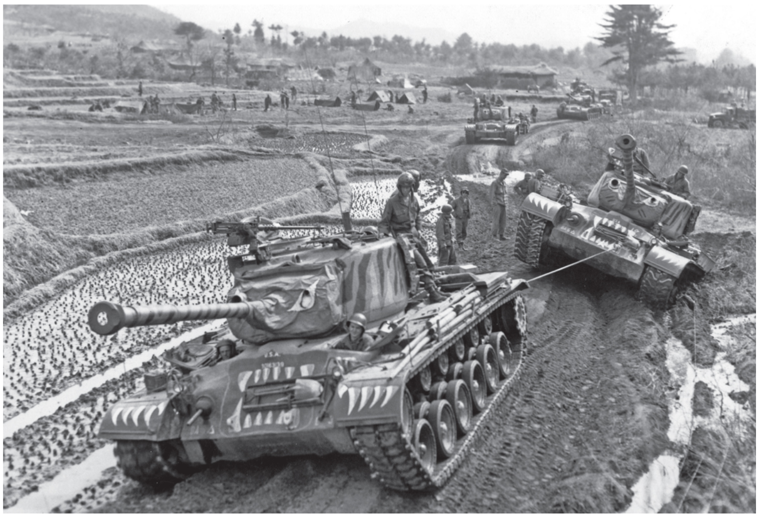
On June 6, 1950, six years after the D-Day amphibious landings in Normandy, Secretary of the Army Frank Pace, Jr. addressed the graduating class of the US Military Academy at West Point. He announced that in his view, “It may well be that tank warfare as we know it will soon be obsolete.” Ignoring Pace’s premature declaration about the demise of the tank, the North Korean People’s Army, spearheaded by Soviet-supplied T-34-85 tanks, invaded South Korea on June 25, 1950.

The unexpected war on the Korean peninsula led to a series of violent tank battles in the summer of 1950. Although the North Korean army was largely destroyed by the end of 1950, the conflict highlighted the dismal state of the US tank force in early 1950. It served as the catalyst for the most intense buildup of the US tank force during the Cold War.

Korea had been occupied by US and Soviet forces in 1945 with the Red Army to the north of the 38th Parallel and the US Army to the south. With the onset of the Cold War, both areas set up their own rival governments with promises to unify the country under their respective control. The US Army largely abandoned South Korea in 1949 except for small training detachments. Although the Republic of Korea (ROK) had begun to set up its own ROK army (ROKA), the US government was reluctant to provide it with offensive weapons more powerful than small arms because of concerns that the Syngman Rhee government would attempt to reunify the country by force. The Soviet Union and China in the meantime had equipped the North Korean People’s Army (NKPA) with the full understanding that the Kim Il Sung government had the same ambitions. Feckless US diplomacy led Stalin and Mao to conclude that Korea was outside the US sphere of influence after the 1949 troop withdrawals, and so gave the North Koreans the green light to initiate the war. Under the cover of peace negotiations, on June 12–

23 the NKPA moved seven infantry divisions and the 105th Tank Brigade to within 10–15km of the 38th Parallel separating the two zones. The plan was based on a marked superiority of the NKPA over the ROKA, with a 2:1 advantage in troops and rifles, a 7:1 advantage in machine guns, and a 13:1 advantage in submachine guns. The ROKA had no significant field artillery or tanks. The June plan, completed with Soviet assistance, expected that the NKPA would advance 15–20km per day and that the campaign would last 22–27 days.

While the NKPA tank force seems puny by today's standards, in 1950 this was the most formidable force in Asia except for the Soviet Army. Japan's armored force had been destroyed in the war, and China's armored force was a motley collection of captured Japanese and American tanks. The US Army had no substantial tank force in occupied Japan beyond four companies of M24 Chaffee light tanks and had withdrawn the medium tanks used in the occupation of South Korea in 1949. South Korea had no tank force, and its only armored vehicles were 37 M8 armored cars and a small number of M3 half-tracks. Anti-tank weapons were poor and consisted of 140 ineffective 57mm anti-tank guns and about 1,900 2.36-inch bazookas.



One of the more curious innovations on US Army tanks in Korea in late 1950 was the practice of painting gaudy tiger faces on the front to scare Chinese troops. Here, an M46 of the 6th Tank Battalion helps extract another M46 from a muddy rice paddy on April 2, 1951, near Chongpyong. These colorful tiger markings remained in use until later in the spring when they were overpainted during periodic overhaul.

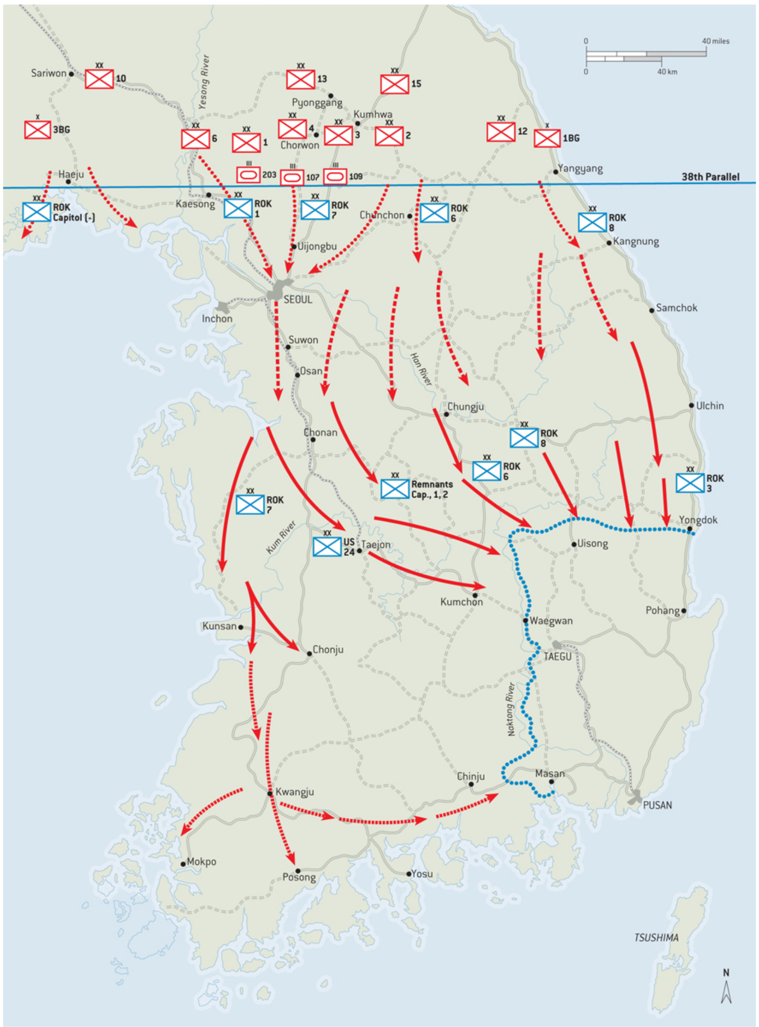
A column of M4A3E8 tanks of "Rice's Red Devils," Co. C, 89th Tank Battalion, near the Han river in March 1951. The company was named after the unit commander, Capt. Clifford Rice, and had the front of their tanks painted with bright red devil faces.

The NKPA planned to use the 105th Armored Brigade as the spearhead of its invasion of South Korea. The brigade was based around the 107th, 109th, and 203rd Tank Regiments. It received its full complement of T-34-85 tanks in October 1949, with each regiment receiving 40 tanks. The brigade also included the 308th Armored Battalion with 16 SU-76M assault guns, and the truck-mounted 206th Motorized Infantry Regiment. The brigade went through intensive training through the spring of 1950.

Korea is an extremely mountainous country, particularly along its eastern coast. The traditional invasion route has been along the western coast, as the mountains gradually give way to a coastal plain. Equally important, the South Korean capital of Seoul was located in this area, so it was the natural destination of the 105th Armored Brigade. Contrary to Soviet doctrine, the brigade did not fight as a single unit, but its regiments were doled out to support NKPA infantry divisions.

THE NORTH KOREAN TANK ASSAULT

The lead NKPA tank unit was the 109th Tank Regiment, spearheading the NKPA 3rd Infantry Division. These units were the first across the border at 0500 hours on June 25, 1950 near Sachang-ni in the westernmost section of South Korea. This unit overran the ROK 17th Infantry Regiment. The other NKPA units soon followed. The 203rd Tank Regiment led the attack of the NKPA's 1st Infantry Division and struck along the Kaesong–Seoul "Unification" highway. The 107th Tank Regiment, leading the NKPA 4th Infantry Division, attacked along the Yonchon–Seoul road, in the center of the other two tank regiments. It crushed several units of the ROK 7th Infantry Division.


0
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Haeju
Yangyang
38th Parallel
ROK Capitol (-)
Kaesong
ROK 1
ROK 7
Chunchon
ROK 6
ROK 8
Kangnung
Uijongbu
SEOUL
Inchon
Samchok
Suwon
Osan
Han River
Chungju
Ulchin
Chonan
ROK 8
ROK 6
ROK 3
Remnants Cap., 1, 2
ROK 7
Kum River
US 24
Taejon
Yongdok
Uisong
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Pohang
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◀●●●● North Korean attacks

◀▬ ▬ North Korean attacks

◀━━ North Korean attacks

◀┅┅ North Korean attacks

●●●●●●● The Pusan defense perimeter, evening August 4, 1950

The North Korean Invasion, June 25 to August 4, 1950. (© Osprey Publishing)

Most South Korean troops had never seen a tank before, and the ineffectiveness of their 57mm guns and 2.36-inch bazookas was demoralizing. Several Korean infantry units attempted to stop the tanks with improvised satchel charges or TNT blocks wrapped around grenades. Many brave Korean infantrymen died trying to stop the fearsome tanks, some 90 soldiers of the 1st Division alone being lost using these desperate tactics. The helplessness of the South Korean infantry at the hands of the North Korean tanks led to tank panic, which eroded the ROK defenses.

After overcoming the remaining defenses of the ROK 7th Infantry Division, the NKPA 107th and 109th Tank Regiments met up at Uijongbu on June 27, which served as the staging point for the main attack on Seoul. Following the capture of Seoul on June 28, the brigade moved to the Han river. In panic, the main railroad bridge over the river was blown up prematurely with heavy ROK traffic still on it, killing several hundred soldiers and civilian refugees. This catastrophe left significant elements of the ROK army trapped on the northern side of the Han river, along with most of their heavy equipment. After overcoming the ROK troops on the northern bank of the river, the NKPA engineers needed several days to lash together improvised means for the tanks to cross the downed sections. The first tanks were not across until July 3. The 109th Tank Regiment took part in the capture of the port of Inchon on July 3.

In the meantime, the US Army began mobilizing forces to rush to Korea and won United Nations approval for a multinational campaign. The first source of troops came from units stationed on occupation duty in Japan. Task Force Smith from the 24th Infantry Division was the first to arrive, consisting of about 400 infantrymen. On July 5, the NKPA had its first encounter with Task Force Smith near Osan, when the US infantry unit was attacked by 33 T-34-85 tanks of the 107th Tank Regiment. US 105mm howitzers began engaging the tanks with high-explosive ammunition, which killed many NKPA infantry riding the tanks Soviet-style but failed to stop the tanks themselves. The US infantry fired on the tanks with two 75mm recoilless rifles, which proved useless. A 105mm howitzer battery waited until the tanks were within 500 yards and managed to knock out the two lead T-34-85 tanks using HEAT (high-explosive anti-tank) ammunition. However, there were only six HEAT rounds, which were quickly exhausted, and the normal high-explosive ammunition proved ineffective in stopping the remaining tanks. The battalion's main anti-tank weapon, the 2.36-inch bazooka, was equally ineffective, and no fewer than 22 rockets were fired without effect. The task force managed to disable only four tanks before being forced to retreat. Task Force Smith lost about 150 men – over a third of its strength – in the one-sided battle.

The 34th Infantry Regiment was the first large US unit to arrive and deployed around Chonan. When attacked by T-34-85 tanks on July 8, the regimental commander, Col. Bob Martin, attempted to rally his dispirited troops in the street fighting. After grabbing a bazooka, he faced down a T-34-85 tank in the town, but the bazooka rocket failed to stop the tank. He was killed by tank fire at close range; the US positions disintegrated against the relentless tank assaults.

On July 9, the North Korean 105th Armored Brigade, recently given the honorific title of 105th Seoul Tank Division, was united near Suwon for further operations. Up to this time, the brigade had lost only two tanks to mines and two more in the fighting with Task Force Smith. The NKPA's heaviest armor losses occurred on June 28, when seven of the brigade's 16 SU-76M assault guns were knocked out by counter-battery fire from the 105mm howitzers of the ROK 6th Infantry Division near Chunchon.

By now, the United Nations operation to thwart the NKPA invasion was beginning to take shape, but American air actions against the armored spearheads were ineffective in early July, contrary to pilots' claims. The four US Army divisions with the Eighth Army in Japan – the 7th, 24th, 25th Infantry, and 1st Cavalry – nominally had an attached tank battalion, respectively the 77th, 78th, 79th, and 71st Tank Battalions. But because of the narrow roads and delicate bridges in Japan, they in fact only had a single company from each battalion equipped with the M24 Chaffee light tank. These were rushed to Korea.

The first of these to see combat was Co. A, 78th Heavy Tank Battalion, which supported the 21st Infantry Regiment of the 24th Infantry Division at Chonui, just south of Chonan, on July 10. They were hopelessly outclassed by the Korean T-34-85s; they scored several direct hits on the T-34-85s, disabling only one. Two M24s were lost in the first day of fighting when their poorly maintained gun recoil systems malfunctioned, wrecking the guns and the turrets. Three more M24s were lost the following day. The M24 was vulnerable not only to the T-34's 85mm gun, but also the NKPA's 14.5mm PTRS anti-tank rifles, which the American tankers labeled "buffalo guns." The poor performance of the M24 against the T-34-85s demoralized the crews, and the tankers proved to be very skittish in supporting the infantry in the ensuing battles for the Kum river line, even without NKPA tank opposition. By August, only two tanks of the original 14 in the company survived. The other two tank companies also were roughly handled: Co. A, 71st Tank Battalion, lost most of its tanks by early August, and Co. A, 79th Tank Battalion, suffered several unequal skirmishes with T-34s. US Army commanders soon lost confidence in tank support and pleaded instead for better anti-tank weapons. Supplies of 3.5-inch "super-bazookas" were airlifted to Korea in mid-July.

An M24 light tank named "UN Cops" of the 3rd Reconnaissance Company, 33rd Infantry Division, takes watch on a hill outside Seoul on April 23, 1951.

With the US defenders lacking any tank support, NKPA infantry from the 3rd and 4th Divisions overcame US resistance along the Kum river in mid-July. The 107th Tank Regiment moved across the river around July 16 to support the assault on the surviving elements of the US Army's 24th Infantry Division at Taejon. Taejon was the first time that the 3.5-inch bazooka was available, and it was first used in action on July 20, knocking out two T-34-85 tanks in the first encounter.

Through the course of the day, tank-hunting teams destroyed or disabled several more T-34-85s in the streets of Taejon, including a team led by Maj. Gen. William F. Dean, the divisional commander. Dean took the personal lead in a tank-hunting mission in the streets of Taejon to convince his troops that the new bazookas could destroy the previously invincible T-34 tanks, especially in the close confines of a town. The NKPA lost about 15 tanks in the fighting for Taejon, its heaviest armored losses to date. Seven of these were due to bazookas, and five were caused by air attacks. Nevertheless, the 24th Infantry Division suffered about 30 percent casualties in the fighting, including Gen. Dean, and Taejon was lost.

THE PUSAN PERIMETER

With the fall of Taejon on July 20, the US Army and South Korean forces pulled back over the Naktong river to the Pusan perimeter at the southeastern-most tip of Korea to await further UN reinforcements. The main source of North Korean tank casualties in late July was due to the poor road conditions in the mountainous country leading toward the Pusan perimeter. The tanks began to show the first signs of wear caused by the intensive actions of the previous weeks of fighting and by the harsh terrain; some tanks had to be cannibalized for parts. More tank losses were suffered at Kumchon on July 23, when several tanks were destroyed in minefields, and several more were knocked out by bazookas during a bloody battle with the “Wolfhounds” of the 27th Infantry Regiment. It was the first time an NKPA armored attack had been stopped by US infantry and proved the effectiveness of the new 3.5-inch bazookas in the hands of determined troops. The minefields and infantry resistance delayed the NKPA tank advance, and on July 28, the UN air attacks finally began to have effect when at least five tanks were knocked out by rocket and napalm attacks. By early August, the operational strength of the brigade was down to only about 40 T-34-85 tanks, with many others waiting by the roadside for repair. Although the air attacks did not destroy the number of tanks claimed, they did disrupt the supply of spare parts and replacement tanks.

The 72nd Tank Battalion was the first unit to arrive in Korea with any significant number of M26 tanks, like this one named "Margaret" of Co. C in action in the Pusan perimeter on August 27, 1950.

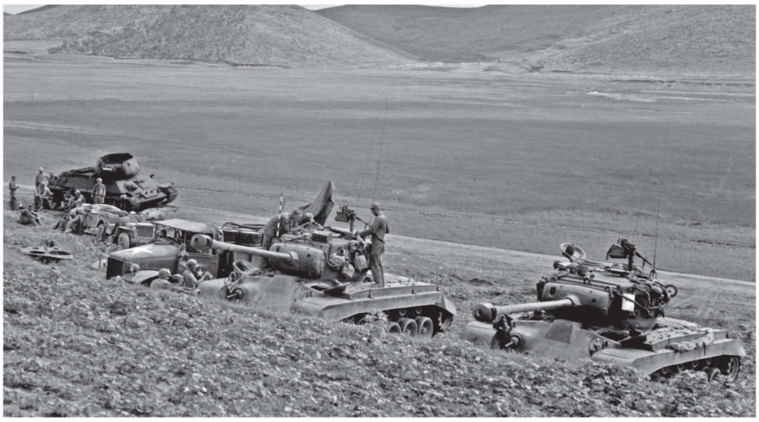
The air attacks led the NKPA armored brigade to change its tactics, and large-scale movements were confined to night to avoid the UN aircraft. Attempts to cross the Naktong river were rebuffed at least twice by air attacks which claimed another five tanks. In the meantime, another US tank action took place. Three broken-down M26 Pershing tanks had been discovered at the Tokyo Ordnance Depot and were quickly refurbished and shipped to Korea. They formed a provisional tank platoon alongside a small number of M24 Chaffees. They were used in attempts to defend Chinju from the NKPA 6th Infantry Division on July 28, but they broke down during the fighting and were abandoned.

The Marine Corps Co. A, 1st Tank Battalion, was the first of the stateside units to arrive in Pusan on August 2, 1950 and the first deployed into combat. The four US Army tank battalions mobilized in July 1950 began to reach the embattled Pusan perimeter by mid-August. The first Army medium tank unit in action was the 89th Tank Battalion, equipped with three companies of M4A3E8s and one of M26 Pershings; the surviving M24s of the 79th Tank Battalion were attached as a fifth company. The battalion's introduction into combat was not auspicious. A tank company of M4A3E8 Shermans led an attack near Masan on August 2 and were ambushed by an NKPA 45mm antitank platoon, which knocked out eight tanks in quick succession. This unit saw no tank fighting in early August but was extensively and successfully used in support of local infantry actions. As US Army and Marine tank strength began building up in the Pusan perimeter, the UN forces began to conduct a more vigorous defense, including some local counterattacks. The tide was beginning to turn in favor of the UN very slowly, and the US Army was regaining its confidence in its tank units.

The NKPA 105th Armored Brigade finally made it across the Naktong river and took part in the attacks on Taegu on August 12, 1950. The 2nd Battalion of the 109th Tank Regiment was decimated by severe UN air attacks on Chonju around August 13, with the regiment losing 20 tanks and having several more damaged. The surviving tanks of the 105th Armored Brigade were dispersed and supported NKPA infantry assaults on the towns all along the Pusan perimeter, rather than being concentrated for one major blow. Finally, on August 15, an independent tank battalion with 21 T-34-85 tanks from the Sadong tank training center arrived to make up for the losses of the previous weeks of fighting. During the river crossing of the Naktong near Waegwan, the brigade was again subjected to merciless air attack.

DUEL AT OBONG-NI RIDGE

US Marine tanks were the first to defeat the invincible NKPA T-34-85s. By mid-August 1950, the North Korean offensive was running out of steam in the face of increasing resistance from US and ROK forces. The first efforts to break out of the Pusan perimeter had begun on August 17, 1950 with attacks toward the Naktong river. The 5th Regiment of the 1st Provisional Marine Brigade was assigned to seize the Obong-ni Ridge, better known to the Marines as “No Name Ridge” – a mile-long series of hills averaging about 350 feet in elevation. On their northern flank was the US Army’s 9th Infantry Regiment. It was supported by a platoon of four M26 Pershing tanks of Able Company, Marine 1st Tank Battalion, led by Lt. Granville Sweet. Opposing them was the NKPA 4th Infantry Division, supported by the 2nd Battalion, 109th Tank Regiment. The fighting that day was dominated by infantry actions with the American assault supported both by artillery and air strikes. By early evening, the 5th Marines and the US Army's 9th Infantry began to set up defensive positions for the night. Around 2000 hours, Lt. Sweet received the radio message "Flash Purple," the Marine code for imminent tank attack. The Pershing tanks were in the process of refueling and they moved forward individually as they completed their task. To this point, the T-34-85 tanks had proven invincible, but Sweet was determined that his platoon would halt the North Korean drive if only by blocking the road through a narrow defile with the hulks of their tanks. The 1/5th Marines had set up a tank ambush, though there was little confidence that it would do much good against the North Korean tanks. A company of 75mm recoilless rifles was set up on a small elevation dubbed "Observation Hill" that had a clear field of fire toward the road. Marine positions forward of the tank platoon had deployed their 3.5-inch bazooka teams on Hill 125 that covered the road on the north side.

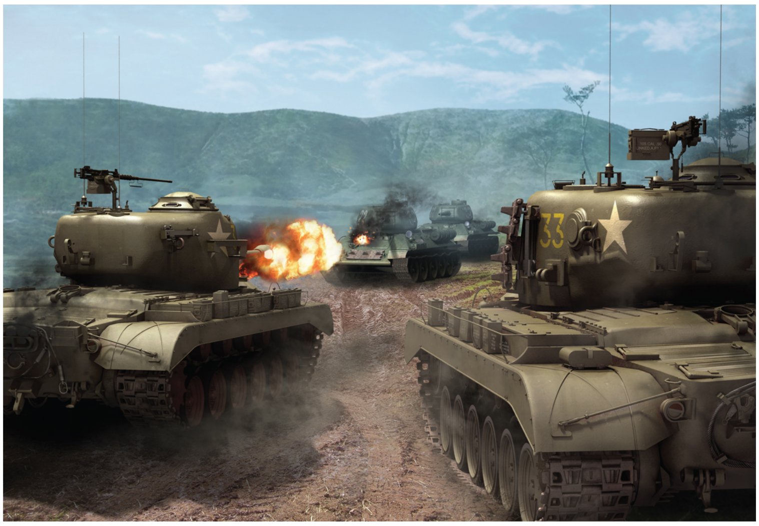


This photo was taken of a pair of M26 tanks of Co. A, Marine 1st Tank Battalion, probably on August 18, 1950, a day after the duel near Obong-ni Ridge, which can be seen in the background. The T-34-85 in the background is No. 314, the tank of the commander of 2nd Tank Battalion, 109th Tank Regiment, which escaped the initial ambush but which was hit by bazooka fire from the US Army 9th Infantry holding the hill to the north. It suffered a turret ammunition fire which blew off the roof, which can be seen to the left of the Pershing tanks.

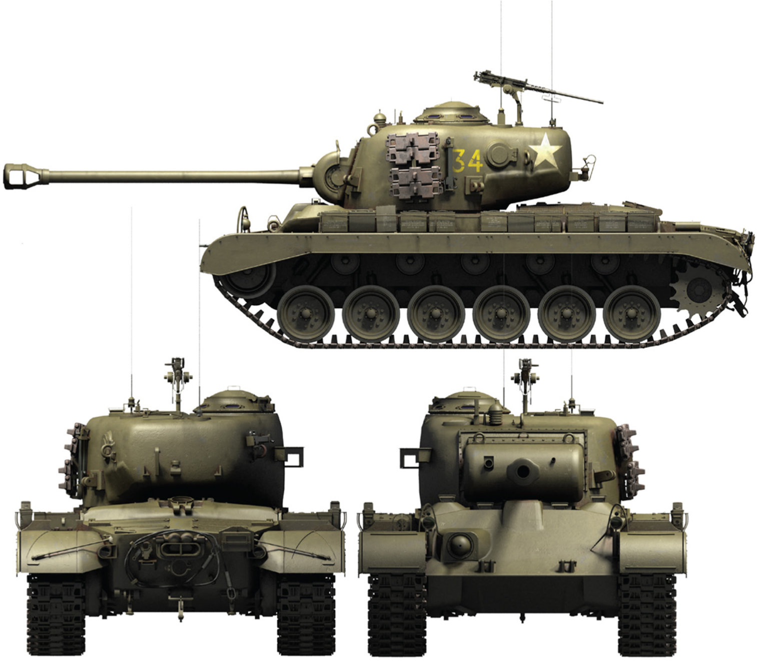
The North Korean column was first hit by an air attack by Marine F4U Corsairs, which stripped away some of the accompanying infantry; the Marine pilots also claimed to have damaged one T-34-85 tank. The

Marines on Hill 125 began firing bazooka rockets at the lead tanks of the NKPA column, which set some of the external fuel tanks on fire. They continued to advance despite the damage. Sweet radioed his platoon to try using the new hyper-velocity ammunition against the approaching tanks. As the tanks rounded the corner, they were pummeled by a volley of tank fire at point-blank range. The Marines knocked out the three lead T-34-85 tanks; the battalion commander in the last tank tried to escape back down the road but was stopped by Army bazookas.

The official Marine history later recalled that the duel had "shattered the myth of the T-34 in five flaming minutes." The T-34-85, once dreaded as invincible, was now derisively called the "Caviar Can." The NKPA attack employed careless tactics. Until this point in the war, the T-34-85 had nothing to fear from any weapon, so the Korean tankers were overconfident. The Marine tankers were surprised that the T-34-85 tanks continued to advance around the corner, even after the first tank had been hit. Nor were the Marines impressed with Korean gunnery skills. The NKPA tank crews seemed unprepared for action and failed to respond quickly enough once the firefight began. This duel near the Obong-ni Ridge also reinforces a conclusion of operational research on tank-vs.-tank fighting in World War II: the tank that sees the enemy first, and fires first, is the most likely winner of the duel. A study of US tank engagements in Korea concluded that the M26 had an effectiveness of 33.1 percent when firing first, but only 0.5 percent when firing second in tank duels. Not surprisingly, tanks in a defensive position consistently had a significant advantage in tank duels since they tended to locate and engage first against an approaching opponent. Overall, tanks firing from defensive positions tended to be three times more effective in the US case, and two times more effective in the North Korean case.



Lt. Granville Sweet's platoon of M26 Pershing tanks during the duel against NKPA T-34-85 tanks at Obong-ni Ridge, August 17, 1950. (Artwork by Richard Chasemore © Osprey Publishing)



M26 Pershing. (Artwork by Richard Chasemore © Osprey Publishing)

The NKPA partly redeemed its fumbling attack a few weeks later on September 5, 1950, in the same location, when two more T-34-85 tanks supported by a pair of SU-76M assault guns and a company of infantry attacked the same location. The M26 tanks of the 1st Platoon rushed forward, but with their turrets in the wrong direction, both were hit by

85mm fire and knocked out. The NKPA armored vehicles were all knocked out by bazooka fire.

THE BOWLING ALLEY

The next heavy tank fighting took part farther north near Tabu-dong where the US Army 27th Infantry Regiment was attacking to relieve pressure on Taegu. Co. C, 73rd Tank Battalion, was assigned to support the infantry. On the night of August 27, 1950, the NKPA began its last major tank action down the valley, from elements of the 107th Tank Regiment reinforced by some new tanks and crews from the Sadong tank school. Tracer fire came barreling down the road through the center of the valley, leading to its nickname, “the Bowling Alley.” The NKPA attack was roughly handled by the infantry and Pershing tanks, and in two days of fighting, the North Koreans lost 13 T-34-85 tanks and five SU-76M assault guns.

After the tank skirmishes, it became increasingly risky for the NKPA to mass armor, as the UN air forces had become much more prevalent over the Pusan perimeter and tanks were a high-priority target. The end of August saw the final commitment of the NKPA tank force. An assortment of partially formed tank regiments and brigades were sent south for an intended offensive to smash the Pusan perimeter starting on September 1, 1950. In total, about 150 T-34-85 tanks had been committed to the initial assault on South Korea, and this second wave totaled about 100 tanks. The second wave of NKPA tank units was far more poorly trained than the elite 105th Armored Brigade.

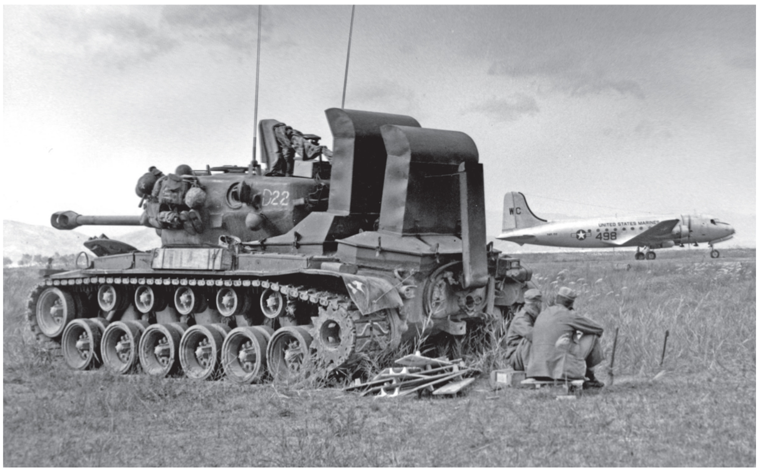
The North Korean infantry, almost as poorly equipped as the South Korean army as far as anti-tank weapons were concerned, would often try to overwhelm American tanks by massed infantry attack, hoping to pry open a hatch. It was a costly tactic but sometimes worked, especially at night or in close terrain. While the bulk of the NKPA attention was focused on the Pusan perimeter and the September Naktong offensive, a far more serious threat was about to strike them from behind.

On the night of August 27, 1950, the NKPA 109th Tank Regiment began its last major tank action down the Bowling Alley near Taegu against the US Army 27th Infantry. It was stopped by tank fire from Pershings of Co. C, 73rd Tank Battalion. After the fighting, an M26 Pershing drives past some of the wrecks.

THE INCHON LANDINGS

By September 1950, the UN forces in the Pusan perimeter had gained numerical superiority over the NKPA forces besieging them. However, the area outside the perimeter was very mountainous, and the UN commander, Gen. Douglas MacArthur, opted for a bolder approach to turn the tide against the NKPA. In a brilliant and risky gamble, the X Corps was assigned to stage an amphibious landing behind the main NKPA forces at the port city of Inchon on the Yellow Sea coast west of Seoul. MacArthur hoped that the sudden appearance of a strong UN force positioned at Seoul deep in the rear of the main NKPA forces would cause them to go into headlong retreat.

The X Corps assault force for the Inchon landing was the 1st Marine Division, supported by the 1st Marine Tank Battalion, followed by the US Army 7th Infantry Division with its 73rd Tank Battalion. The landings were conducted beginning on September 16 using LVT-3 amtracs, since the coastal mud in the beach area was too thick for the Marines to wade ashore from landing craft. The assault landed in three areas: in the early morning at Green Beach on Wolmi-do Peninsula, and in the afternoon at Red Beach and Blue Beach on either side of Wolmi-do. The ferocious tides in the approaches to Inchon and the limited resources did not permit a simultaneous landing. The only North Korean armor encountered in the initial landing at Wolmi-do was a BA-64 armored car, which was blown apart by a 90mm round from a Marine M26 Pershing.

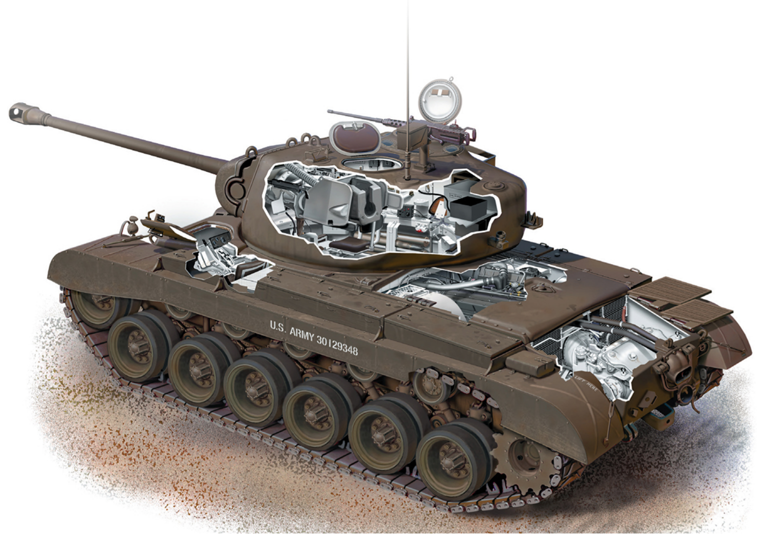


On October 27, 1950, another amphibious landing was conducted at Wonsan, on the eastern coast of Korea, by the 1st Marine Division. By this time, the NKPA was in total disarray, and the landing was unopposed. The M26 tanks of Co. D, Marine 1st Tank Battalion, were fitted with the full deep wading trunks for the operation to allow the tanks to be landed in the shallow harbor from LCUs (Landing Craft Utility). Here, one of the tanks sits near the airbase with its wading trunks still attached.

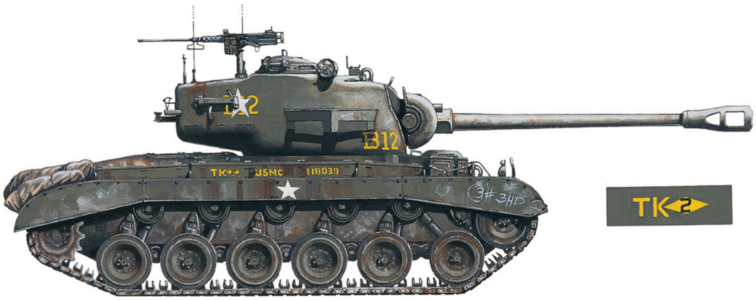
The North Koreans had been warned by Soviet intelligence of the planned landing based on information from British spies. However, North Korean potentate Kim Il-Sung ignored the warnings and concentrated instead on renewed attacks on the Pusan perimeter. The North Korean leader expected that a collapse of the Pusan perimeter was imminent, and that the amphibious assault on Inchon and Seoul would be preempted by the need to rescue surviving US forces at Pusan. Instead, the US forces in Pusan were on the verge of breaking out, and Seoul was only weakly defended.

The NKPA had only the inexperienced 42nd Mechanized Regiment with 18 T-34-85s in the Seoul area, but once news arrived of MacArthur's assault, the 105th Armored Brigade was ordered to withdraw back north, and the new 43rd Tank Regiment, with ten to 15 T-34-85s, was transferred from Wonsan. A company of fewer than ten T-34-85 tanks of the 42nd Mechanized Regiment tried to intervene during the late afternoon of September 16, but three were knocked out by air strike, and three more by Marine M26s. On September 17, 1950, six T-34-85 tanks, their crews blissfully munching on their breakfast, stumbled into the 5th Marines who were moving on Kimpo airbase. The Marines were supported by M26 Pershing tanks of the 1st Marine Tank Battalion, and all six T-34s were destroyed in a storm of recoilless rifle and tank fire without loss to the Marines. A short time later, the burning NKPA column was passed by Gen. MacArthur, who commented, “Considering that they’re Russian, these tanks are in the condition I want them to be!”

Most of the tanks in Inchon and Seoul were destroyed by Marine bazooka teams. A total of 24 T-34-85s were destroyed from September 16 to 20, thereby eliminating the 42nd Mechanized Regiment. Another 12 T-34-85s from the 43rd Tank Regiment were knocked out on September 25, including at least seven by Marine tanks. The main task of the Pershings in the Seoul fighting was providing close fire support during the street fighting. The NKPA had erected barricades across most of the major streets, and the Marine tanks were used to help break up these defenses in savage street fights.



M26 90mm medium tank, 1945. (Artwork by Jim Laurier © Osprey Publishing)



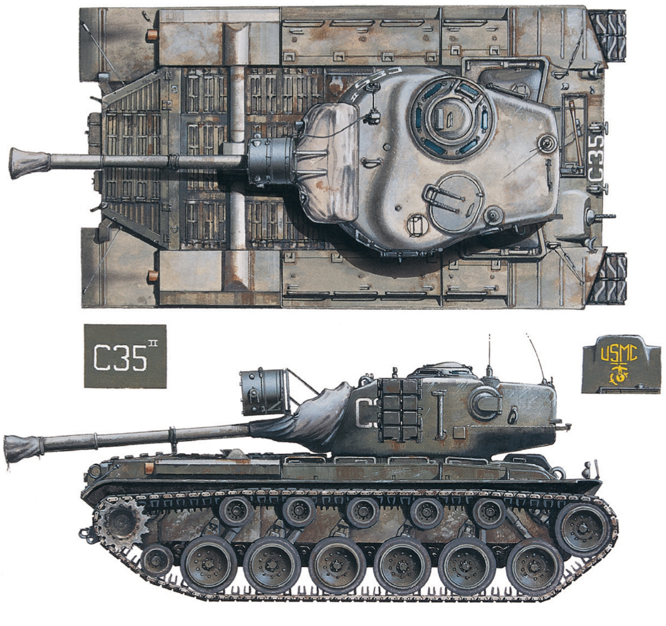
M26 Pershing, Marine 1st Tank Battalion, Korea, 1950. (Artwork by Tony Bryan © Osprey Publishing)

On September 20, Co. B, 73rd Tank Battalion, supporting a drive by the 31st Infantry, ran a gauntlet of North Korean defenses along the Suwon road, losing one M4A3E8 to Korean tank fire, but destroying eight T-34-85 tanks. A portion of the unit later repulsed a North Korean tank attack near the airstrip, destroying three more T-34-85 tanks after they had run over four scout jeeps. In the final tank action by the battalion near Seoul, Co. A entered Suwon from the western side of the town and knocked out four more T-34 tanks. The column, in support of Task Force Hannum, continued south toward Osan, where four more T-34-85s were encountered and destroyed.

BREAKOUT FROM THE PUSAN POCKET

While MacArthur was landing at Inchon, plans were underway to begin a breakout operation by the Eighth Army from the Pusan perimeter. The North Koreans had reinforced their forces opposite the pocket with the newly raised 16th and 17th Armored Regiments prior to the beginning of the September 1 Naktong offensive. The offensive, although very costly to both sides, had failed, and the NKPA was near breaking point with its units decimated and its troops exhausted and on the brink of starvation.

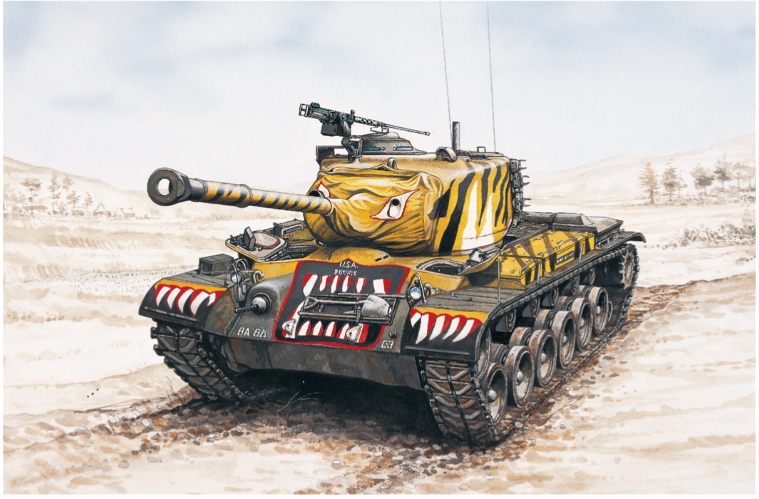
The Eighth Army counteroffensive was scheduled for a day after the Inchon landings, September 17, in order to take advantage of any panic that might set in among the North Korean troops after word arrived of the Inchon landings in their rear. A broad offensive began with the aim of convincing the NKPA to retreat. As news of the Inchon landings arrived at NKPA headquarters, a general retreat by the NKPA northward began as expected. The NKPA force, which had been cocky and victorious only weeks before, had been decimated in their early September offensive against the increasingly strong US forces. By the time that the retreat order was issued, many units were starving and demoralized. The units were ordered to fall back on Seoul, but many soldiers instead headed into the mountainous country along the eastern coast, realizing that the US forces were less likely to follow them there. By this time, the 105th Armored Brigade was already withdrawing based on previous orders. There were large numbers of T-34-85 tanks that had broken down during the initial assaults. Many of these had functional weapons, so they were moved into defensive positions along key routes in the hopes of acting as improvised pillboxes to stop the UN advance.



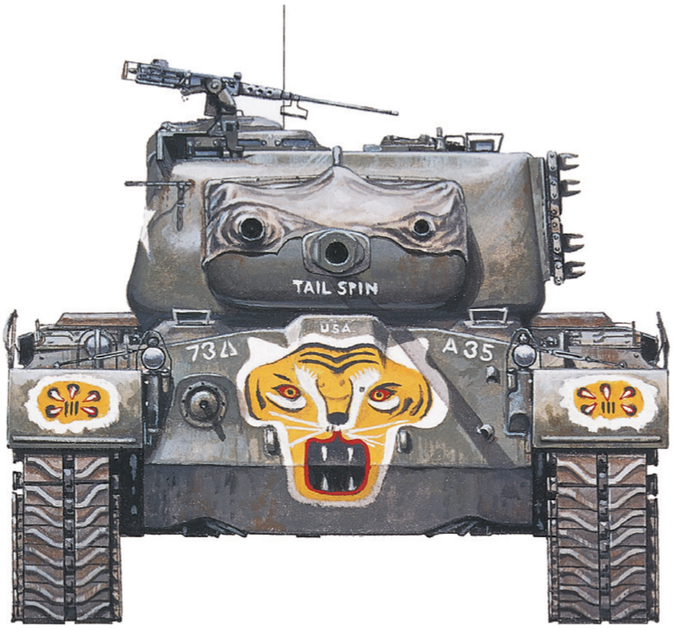
M46 Patton, Marine 1st Tank Battalion, Korea, 1952. (Artwork by Tony Bryan © Osprey Publishing)

The commander of the Eighth Army, Gen. Walton Walker, had served with George Patton in World War II and decided to use a mobile force to spearhead the link-up between the Pusan perimeter forces and MacArthur's X Corps amphibious invasion force in Seoul. He chose a battalion from the 7th Cavalry Regiment reinforced with seven

M4A3E8 tanks from Co. C, 70th Tank Battalion. The spearhead was called Task Force Lynch. The task force set out late on the night of September 21 with the objective of seizing the Naktong-ni ferry crossing site 35 miles north of Tabu-dong. The motorized force moved very quickly against light resistance. With tanks in the lead, the column was finally halted at Naksong-dong when the two lead M4A3E8 tanks were knocked out by an emplaced 76mm gun. The gun position was overcome by infantry, and shortly afterwards, Task Force Lynch encountered the rear elements of the retreating NKPA forces. An enemy ammunition train soon fell victim to tank fire, and a further 20 artillery pieces, 50 ex-US Army trucks, and four T-34 tanks were captured. An NKPA infantry column was caught in the middle of the Naktong river and decimated. The success of the task force in taking its objective led Gen. Walker to order it to continue its lightning advance to the northwest. At the lead was the 3rd Platoon, Co. C, 70th Tank Battalion, under Lt. Robert Baker. Baker's column linked up with the X Corps' 73rd Tank Battalion near Suwon around midnight, September 26/27, the first contact between the Pusan perimeter troops and MacArthur's Inchon force. Task Force Lynch had crossed 102 miles in only 11 hours. Baker's tank platoon, however, had lost contact with the other elements of Task Force Lynch which were still behind him. Later that night, Task Force Lynch was attacked by about ten T-34-85 tanks. The remaining tanks from 2nd Platoon, Co. C, 70th Tank Battalion, moved forward from the rear of the task force to engage them. Two Shermans were quickly knocked out by dug-in T-34-85s, but the third M4A3E8 moved forward and destroyed both. Another T-34-85 got into the infantry truck column and crushed about 15 jeeps and trucks before finally being blasted by a 105mm howitzer at a range of 10 yards. Four other T-34s were destroyed by bazooka teams. That afternoon, the two surviving T-34-85s were chased through the villages of Habung-ni and Pyongtaek where they were finally hit in the rear by tank fire from the 70th Tank Battalion. This encounter was the largest tank-vs.-tank engagement during the breakout.



M46 Patton, 6th Tank Battalion, Korea, 1951. (Artwork by Tony Bryan © Osprey Publishing)



M46 Patton, 73rd Tank Battalion, Korea, 1951. (Artwork by Tony Bryan © Osprey Publishing)

The best-equipped Army tank unit, the 6th Tank Battalion with the new M46 tanks, saw very little tank fighting until October 22, when Co. A encountered eight T-34-85s and one SU-76M and knocked them all out in a brief and one-sided firefight. Eight other T-34-85s were found shortly afterward, all abandoned by their crews.

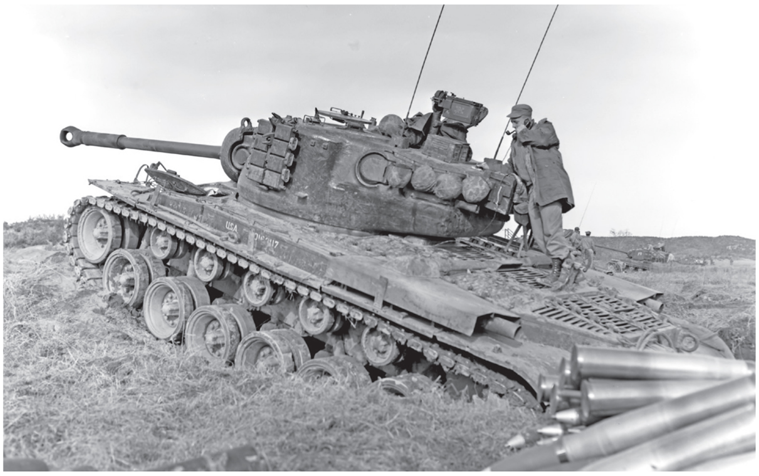
FINAL TANK BATTLES

The heaviest tank-vs.-tank fighting of the Korean War took place from August to October 1950. There were hardly any encounters with North Korean armor after November 1950. The US Army and Marine Corps continued to make extensive use of tanks for infantry support for the remaining two years of the conflict but seldom encountered enemy armor. Other UN forces also employed tanks during the fighting, including British Centurion, Churchill, and Cromwell tanks, and Canadian Shermans. The only British tank duel of the war was fought between a Centurion and a Cromwell tank that had been captured by the Chinese.

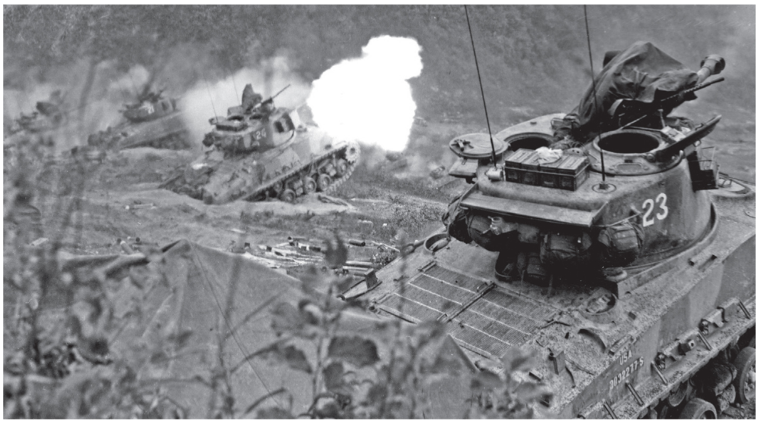
The NKPA received some tank reinforcements from the Soviet Union in 1951 after the Chinese intervention. In 1951, the 105th Tank Division was reorganized as the 105th Mechanized Division, the 17th Mechanized Brigade was given divisional status, and the 10th Mechanized Division was formed though not equipped. A number of separate tank and assault gun battalions were also formed on paper. However, Soviet resupply was completely inadequate to equip these units, and in 1951, the NKPA armored force numbered only 77 T-34-85 tanks and 63 SU-76M assault guns. By 1952, the NKPA decided to drop the pretense and disbanded the 17th and 105th Mechanized Divisions and converted the 10th Mechanized Division back to an infantry unit. The vehicles and crews on hand were used to form six separate tank/assault gun regiments. By war's end, the NKPA armor units numbered 255 T-34-85 tanks and 127 SU-76M assault guns. However, they saw little if any combat in the final years of the war.

On December 6, 1950, the 5th and 7th Marines, trapped by Chinese forces near the Chosin Reservoir, began an attack southward to break out. Here, a column of M26A1 Pershings support the attack. This was one of the epic battles in Marine Corps legend, fought against great odds in appalling weather.

M46 tanks of the newly arrived 64th Tank Battalion take up defensive positions at Kagae-dong in support of the 3rd Infantry Division in an attempt to stem the tide of the Chinese advance on December 7, 1950. The 3rd Infantry Division had moved into the Hamhung–Wonsan area in November to relieve the 1st Marine Division, which was moving forward toward the Chosin Reservoir area. (NARA)



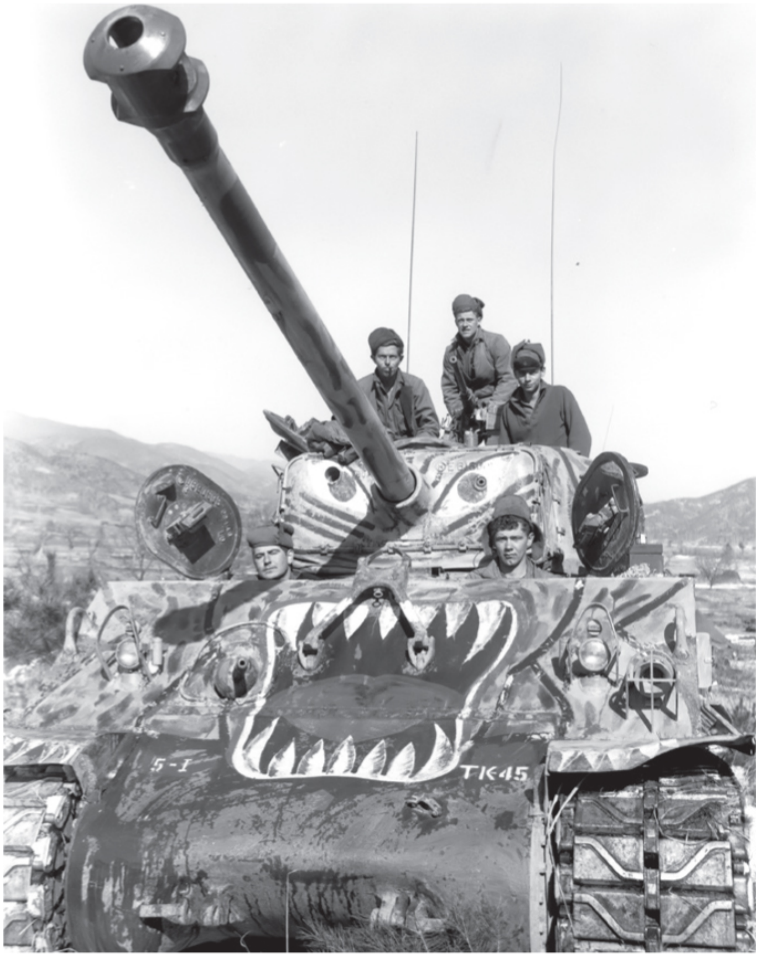
This Marine M46 of Co. A, 1st Marine Tank Battalion, waits for fire instructions on December 15, 1952, while supporting the Commonwealth Division during the fighting in Korea. At the time, the M46 tanks were generally earmarked for Korea while priority for the newer M47 tanks was for the US Army in Europe. The M46 can be distinguished from the M26A1 by the rear engine deck, and especially the prominent mufflers on the mudguards.



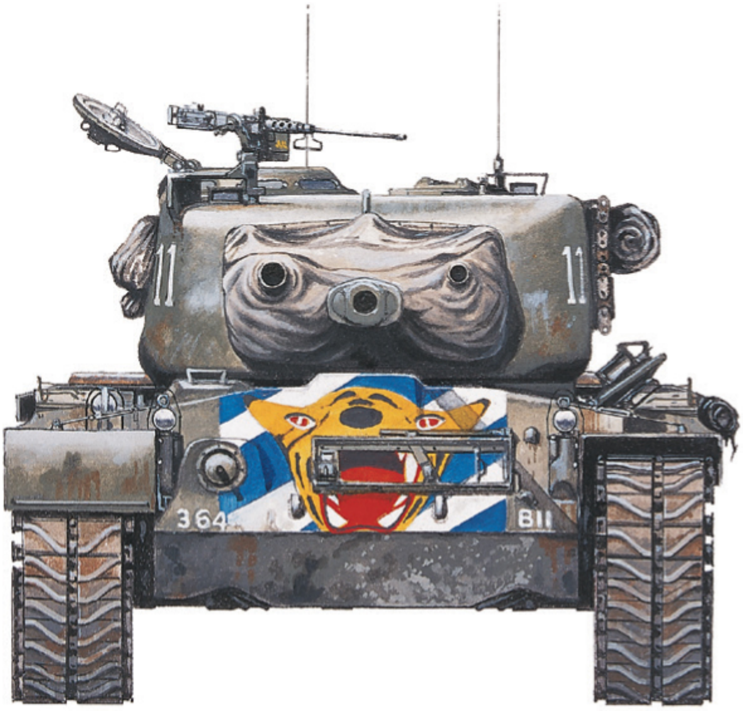
As the Korean War stalemated along the 38th Parallel, the role of tanks changed and they were often used for artillery fire support. Here, some M4A3E8s from the 72nd Tank Battalion provide fire support for the 23rd Infantry, 2nd Infantry Division, north of Pia-ri on the east-central front on September 18, 1951.

The Chinese People's Liberation Army (PLA) had very little tank support during their intervention in 1950. At the end of the Chinese Civil War in 1949, the PLA had a force of 349 tanks, consisting mainly of Soviet-supplied Japanese Type 95 light tanks and Type 97 medium tanks, as well as smaller numbers of American M3A3 Stuart light tanks and M4A4 Sherman medium tanks captured from the Nationalist Kuomintang army during the Chinese Civil War. These were nominally organized into the 1st and 2nd Armored Divisions and two independent tank regiments. By May 1950, the PLA tank force had modestly increased to 410 tanks, mainly by combing the civil war battlefields. Few of these tank units were fit for combat, so in August 1950 the existing units were consolidated into three tank brigades, and the remainder were used to form tank training centers.

In the meantime, the Soviet Union agreed to a major increase in arms sales, intended to support the Chinese involvement in Korea. In October 1950, ten Soviet tank regiments moved into northern China. Over the next three months, the Soviet crews instructed new Chinese crews on the tanks, which were then turned over to the PLA. So, for example, two Soviet tank regiments deployed to Xuzhou where they transferred their equipment to the 3rd and 4th Tank Regiments of the PLA's 2nd Armored Division; a similar process was undertaken with the 1st Armored Division and the two independent regiments. Each Chinese regiment received 30 T-34-85 tanks, six IS-2 heavy tanks, four ISU-122 heavy assault guns, and various support equipment. By 1953, the Soviet Union had sold the PLA a total of 278 T-34-85 tanks, 38 IS-2 heavy tanks, 48 SU-76M light assault guns, and 27 ISU-122 heavy assault guns. In February 1951, the Chinese People's Volunteer Army (CPVA) in Korea was reinforced with four tank regiments: the 1st and 2nd from the 1st Armored Division, the 3rd Tank Regiment from the 2nd Armored Division, and the 6th Separate Tank Regiment. These did not fight as unified formations but were usually spread out to support Chinese infantry formations. So, for example, the 3rd Tank Regiment was split up between the 39th and 43rd Armies during the June 1951 fighting. It took part in 18 engagements and claimed to have knocked out two US tanks. However, the unit was almost wiped out in the process and was withdrawn to China in July 1951. It was replaced a year later in June 1952 by the division's 4th Tank Regiment. A tank of this unit, number 215, claimed five tank kills along with numerous bunkers and other targets and was honored as a "People's Heroic Tank" and displayed at the PLA museum in Beijing. The Chinese tank interventions in Korea were extremely small scale and were so minor that most US accounts assert that no Chinese tanks were encountered in the 1951–53 fighting.



An M4A3E8 Sherman tank of the 5th Tank Company, 5th RCT, 24th Infantry Division, during the fighting along the Han river in February 1951. This company adopted the colorful tiger markings of the 6th Tank Battalion, which was attached to the 24th Division at the time.



M46 Patton, 64th Tank Battalion, Korea, 1951. (Artwork by Tony Bryan © Osprey Publishing)

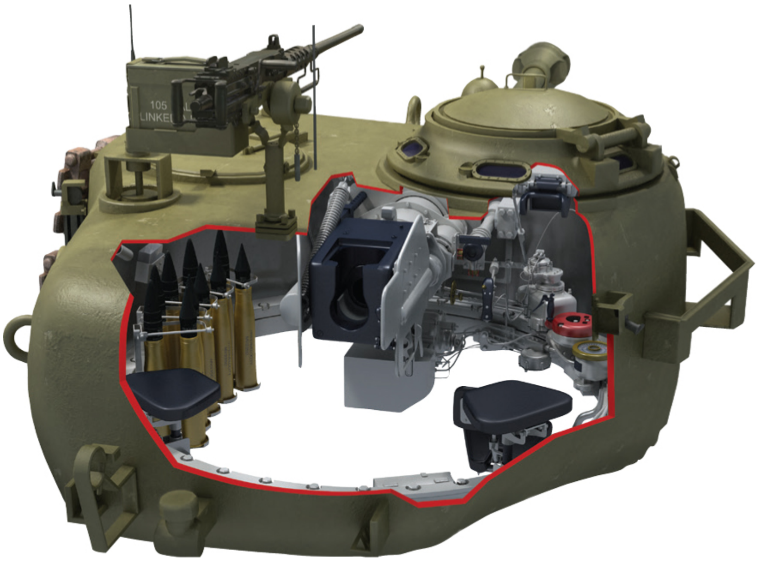
A pair of M4A3E8 Sherman tanks of the 160th Medium Tank Company, 40th Infantry Division, in Korea on May 11, 1952. The added sandbag protection is reminiscent of similar practices in Europe in 1945, but not as common in Korea due to the lack of a Panzerfaust equivalent by the NKPA and Chinese troops.

KOREAN WAR LESSONS

Although the North Korean armored force had substantially outnumbered the US forces at the beginning of the war, by August 1950, the US forces began to enjoy the numerical advantage. By the end of 1950, US tank units in Korea had received 1,326 tanks, consisting of

138 M24 Chaffees, 679 M4A3E8 Shermans, 309 M26 Pershings, and 200 M46 Pattons.

A 1954 operational survey concluded that there had been 119 tank-vs.-tank actions during the war, 104 involving US Army tank units and 15 involving the 1st Marine Tank Battalion. On the US side, the tanks that were involved were the M4A3E8 in 59 actions (50 percent); M26 in 38 actions (32 percent), M46 in 12 actions (10 percent), and M24 in 10 actions (8 percent). Most of the tank battles were on a very small scale, and only 24 engagements involved more than three North Korean tanks. A total of 34 US tanks were knocked out by North Korean T-34-85 tanks or SU-76Ms, of which only 15 were totally lost; the rest were repaired and returned to action. The US tanks knocked out 97 T-34-85 tanks and claimed a further 18 as probable. Not surprisingly, the M24 proved the most vulnerable to enemy tank fire. Most M24 tanks hit by the T-34-85's 85mm gun were lost, with several crew members also being lost due to the thin armor. At least four M24s were knocked out by T-34-85s.



The turret interior of the M26. (Artwork by Richard Chasemore © Osprey Publishing)

Snow billows after an M46 of Co. C, US Army 6th Tank Battalion, fires its 90mm gun while supporting the 24th Infantry Division near Song Sil-li, Korea, on January 10, 1952.

The T-34-85 was generally less able to resist hostile tank fire than the US tanks. It could be penetrated by any of the US medium tanks, while it had difficulty penetrating the M26 or M46 tanks. Furthermore, if penetrated, the T-34-85 crew was far more vulnerable to injury. A US inspection of T-34-85s found that 75 percent of the T-34-85 crews were killed when hit by tank fire, compared to only 18 percent of US medium tanks hit by T-34 fire. This was in part due to the US tanker practice of hitting a tank repeatedly until it burned to make certain that it was knocked out. In general, the study concluded that the T-34-85 was an excellent tank, but that the North Korean crews were not as well trained as their American opponents. The US lost 136 tanks in 1950, the main source of loss (69 percent) due to mines. In terms of performance, the T-34-85 and the M4A3E8 were on fairly equal terms as far as basic performance was concerned. Although the M4A3E8 had a gun of smaller caliber, the widespread availability of HVAP (high-velocity armor-piercing) ammunition made it quite capable of penetrating the T-34-85's armor. Likewise, the T-34-85 had no problem penetrating the armor of the M4A3E8 at normal combat ranges. Because of the mountainous and hilly terrain in Korea, most engagements were fought at very close ranges. The M26 and M46 were a clear overmatch for the T-34-85. They enjoyed thicker armor and heavier firepower. US operational research concluded that the M26 was about three times more effective than the M4A3E8; combat effectiveness was assessed as the ratio of tank losses vs. tank kills along with the relative number of enemy and friendly tanks.

A total of 239 T-34-85 wrecks and 74 SU-76M wrecks were counted by UN intelligence in October 1950, surprisingly close to the figure of 258 T-34-85s initially supplied by Russia. A total of 296 T-34 hulks were identified as of April 1952.

In 1950, the US Air Force claimed to have destroyed 857 tanks in air attacks, several times the number actually present, and about eight times higher than actual results. Through June 1952, the Far East Air Force claimed 1,256 tanks destroyed and 1,298 damaged, plus 123 kill claims by Marine land-based aircraft and allied aircraft, and another 163 tanks destroyed and 161 damaged by Marine Corps and Navy carrier-based aircraft. Of the original 239 T-34-85 wrecks surveyed by US intelligence, 102 were attributed to aircraft (60 percent of these to napalm) and 13 to bazookas; a later assessment downgraded the confirmed air kills to only 29, though many of the unknown kills were likely due to air attack using napalm. The excessive kill claims by aircraft parallel similar assessment issues in World War II. Part of the problem stemmed from aircraft repeatedly hitting the same tanks, as well as the difficulty of distinguishing tanks and trucks when making high-speed passes in poor weather conditions. The Navy was credited with 12 tanks destroyed by naval gunfire. The table below is based on a second and larger survey of the tank wrecks.

NKPA tank losses by cause, July–November 1950

Opponent	Destroyed	Damaged	Total
M24 light tank	1		1
M26 medium tank	29	3	32
M4A3E8 medium tank	41	4	45
M46 medium tank	18	1	19
Tank sub-total	89	8	97
Artillery	20	8	28
Bazooka	11	11	22

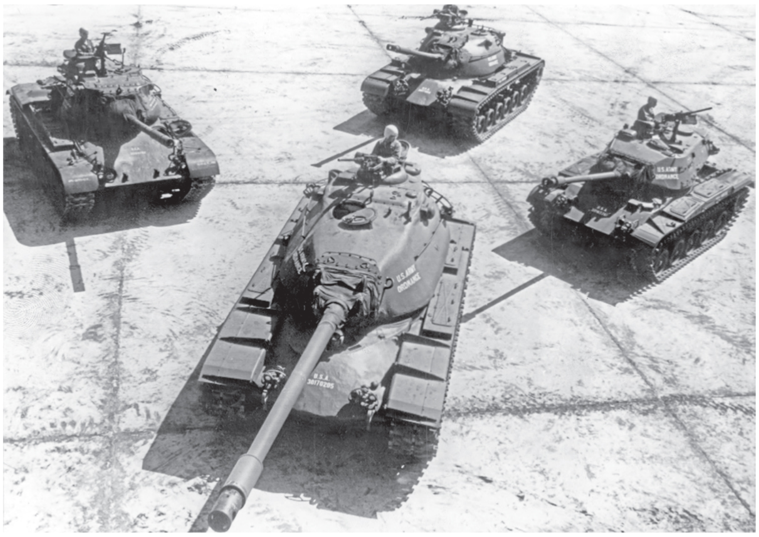
Recoilless rifle	9	4	13
Land mine	1		1
Grenades	3		3
Aircraft	27	2	29
Unconfirmed	63		63
Total	223	33	256

Tempo of T-34-85 losses to US tanks in 1950

	August	September	October	November	Total
M24				1	1
M26	3	21	8		32
M4A3E8	2	23	20		45
M46		4	5	10	19
Total	5	48	33	11	97

The opinion of US tankers toward the various types of US tanks changed in 1951 once the T-34-85 threat disappeared. The M26 Pershing was undoubtedly the most sought-after type in 1950 when the tank fighting was still intense. But once the tank fighting ebbed after 1950, the M26 was shunned due to automotive shortcomings, particularly its sluggish performance and the sloppy transmission performance on hills. The M26 used the same engine as the M4A3E8 Sherman but was substantially heavier. Those tankers with experience in the M4A3E8 preferred it over the M26 since it was more reliable, easy to maintain, and far nimbler to drive. Its automotive performance in the hilly Korean countryside was much superior to that of the M26, and its firepower was perfectly adequate against the rarely encountered T-34. The M46 cured many of the problems encountered with the M26 due to the introduction of a new engine and cross-drive transmission, and so was the preferred version of the two tanks.

The Korean War had profound effects on the US Army's tank force since it was regarded as a surrogate for any Cold War tank confrontation along the Iron Curtain with the Soviet Union. The poor performance of US tanks in the opening phase of the war led to the "Korean Tank Crisis" in Washington, DC, with political leaders castigating the US Army leadership for the poor state of the US tank force. This provided the political and financial will to undertake a hasty modernization of the US Army tank arsenal over the next several years. The crash tank programs in 1950–55 led to a substantial tank production program. Between 1950 and 1960, the US Army procured more tanks than in the following three decades to 1990.

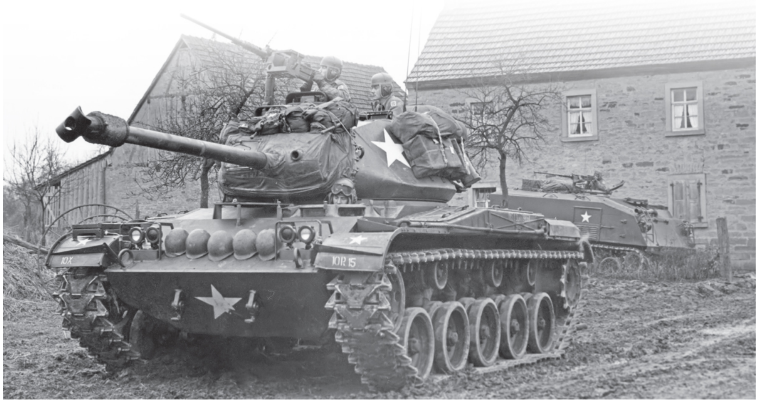


A display in May 1954 following the Korean War showing the Army's new array of tanks, with the T43 (M103) heavy tank in the center, M47 medium tank in the upper left, M48 medium tank in the center, and M41 light tank on the right.

CHAPTER THREE

US TANKS OF THE EARLY COLD WAR ERA

In 1950, the Chief of Army Field Forces complained that no existing US or British tank could "engage the most powerful Russian tanks on equal terms." On July 12, 1950, the Army Field Forces asked the Army staff to put tank procurement on a "crash" basis. Among the specific requests were construction of additional M46s; release of the new T41E1/M41 76mm gun tank for manufacture; procuring additional M46 hulls mounting the improved T42 turret; and procuring 400 of the new T43/M103 heavy tanks.



An M41A1 tank of the 10th Reconnaissance Company, 10th Infantry Division, taking part in Exercise Polo Ball near Würzburg on December 12, 1955. Behind it is an M75 armored personnel carrier.

Gen. Matthew Ridgway, then the deputy chief of staff for administration on the Army staff, approved all of the initiatives except for the heavy tanks. Gen. Ridgway's decision initiated a dramatic expansion of US tank production. By July 1953, more than 23,000 tanks had been funded and more than 12,000 manufactured. Beyond the existing M46, the Army completed development of four new tanks:

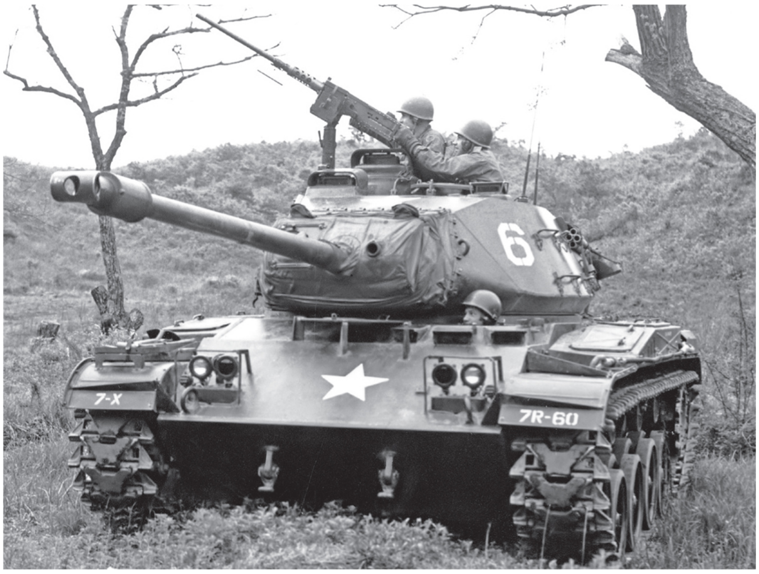
the light M41 Walker Bulldog, the medium M47 Patton II, the medium M48 Patton III, and the heavy M103. The hasty program conducted concurrent development and production for the new tanks, which led to the manufacture of tanks before engineering development and testing were complete. This required numerous upgrade and correction programs to eliminate faults uncovered when the tanks were first deployed.

THE M41 76MM GUN TANK

The T37 light tank program had resulted in a satisfactory new chassis design, but there were some misgivings about the turret and armament. As a result, three alternative turret configurations were developed, labeled Phases 1 through 3, differing in guns, rangefinders, stabilization, and other features. Of the options, the Phase 2 turret seemed to offer the most promise. This included the T91 76mm gun, coincidence optical rangefinder, and the Vickers azimuth and elevation gun stabilization system. A further four pilots were ordered under the new designation of T41. The first pilot was delivered for trials at Aberdeen Proving Ground in the summer of 1949.

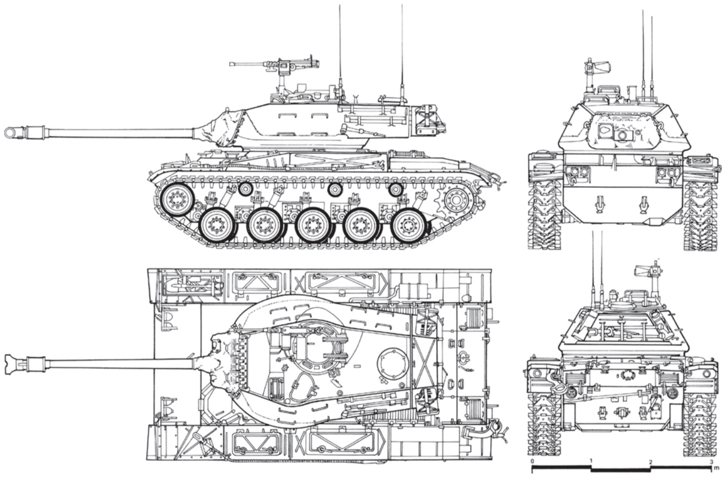
The T41 and T41E1 pilot tanks used a relatively sophisticated fire control system, including a pulsing relay turret and gun control system that provided power traverse and elevation for the gunner as well as a tank commander's override. Due to the Korean War tank crisis, the Army ordered 1,000 T41E1 tanks before all the technical issues were solved. The T41E1 was authorized for production in July 1950 and began in April 1951 at the government-owned Cleveland Tank Plant, operated by the Cadillac Motor Company Division of the General Motors Corporation. The T41E1 was standardized as the M41 light tank. The first eight M41 tanks were completed in July 1951.

In November 1951, the Army changed the basic fire control requirements, insisting that the M41 tank should be able to have the main gun on target by five seconds after a target was engaged. The pulsing relay turret traverse system could not reach these goals. As a result, the first 900 M41 tanks were sidelined until the turret traverse system was corrected. Approval to issue the M41 tank to regular units was withheld until December 1952, when the corrections were introduced. Eventually, 1,785 M41 tanks were manufactured.



An M41A1 tank of the 7th Reconnaissance Company, 7th Infantry Division, during field exercises in the Republic of Korea on May 5, 1955.

Cadillac redesigned the turret traverse system on the improved T41E2 pilots using an oil gear traverse system. The modified system had powered hydraulic traverse for the gunner and the commander's override and manual hydraulic elevation for the gunner. This system was introduced on production tank serial 1419 as the M41A1, and 416 of the earlier M41 tanks were rebuilt to this configuration.



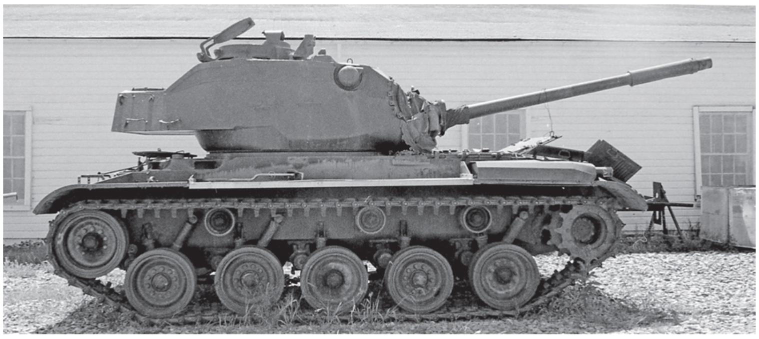
M41A2 76mm tank. (Author)

By July 1952, more than 4,000 engineering design changes had been requested on the M41 alone. Of the 2,294 M41s delivered by July 1953, 1,631 awaited modifications at the Lima, Ohio, Ordnance Depot and at Cadillac's Cleveland plant. The need to correct deficiencies delayed approval for issue of the M41 to regular units until December 1952, and only 20 were in the hands of troops in Europe on April 1, 1953. By the summer of 1952, the Army Field Forces had become so disillusioned with the M41 that it recommended the Army terminate its production as soon as possible and push ahead with acquiring a new light tank. Instead, the Army insisted on completing the production contracts and remedying the technical problems.

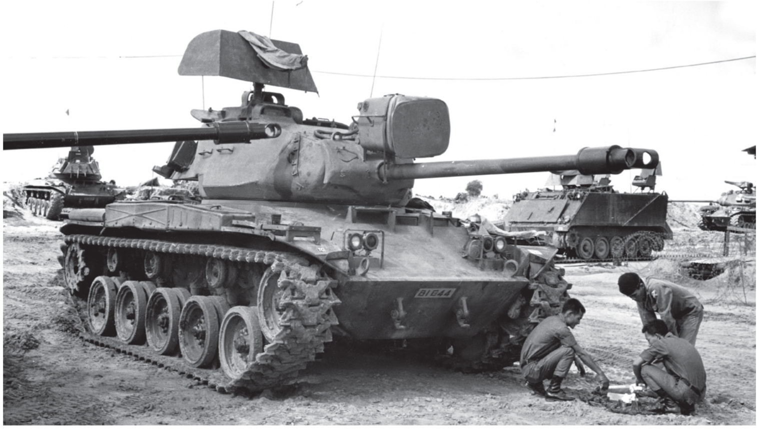
A total of 1,944 M41A1 tanks were manufactured, which, combined with the 416 upgraded M41 tanks, brought the grand total to 2,360 M41A1 tanks. The M41A1 was formally standardized on November 5, 1953, after the end of the Korean War. The M41 was originally nicknamed the "Little Bulldog" but was quickly renamed the "Walker Bulldog" in honor of Lt. Gen. Walton H. "Bulldog" Walker, who had been killed in a road accident during the Korean War.

Like many US tanks of this era, the M41 had poor range – only about 100 miles on the road and less in cross-country travel. The carburetor on the baseline AOS-895-3 engine was replaced by a fuel injection system on the modified AOSI-895-5 engine. The M41 and M41A1 were modernized with upgraded engines as the M41A2 and M41A3 respectively, with modification beginning in 1955.

By the mid-1950s once its bugs were worked out, the M41 proved very popular in service with US armored and armored cavalry units. It was fast, nimble, and responsive, three characteristics much cherished in a reconnaissance tank. The gun was adequate to deal with the Soviet T-34-85 tank. Some former M41 crewmen complained that the turret was cramped due to all the equipment associated with the turret traverse, stabilization, and gun. A more worrying feature was the risk posed to the driver when riding with his head out of the hatch: should the gun traverse leftwards without the driver being warned, serious head injuries could occur. The M41 was also a very noisy tank, having a very loud, whining engine. This was not greatly appreciated by reconnaissance crews; but the peppy performance of the engine counterbalanced its noise.



The T49 was an attempt to improve the armament of the M41 tank using the smoothbore T132 90mm gun. This required an extension to raise the turret roof. This project ended in 1955, although the concept was revived inconclusively in later years. (Author)



The M41 light tank arrived too late to see combat with the US Army in Korea, and was retired too soon for US Army use in Vietnam. However, 241 M41 light tanks were supplied to the Army of the Republic of Vietnam, and formed the backbone of its tank force. They saw extensive combat in the final years of the Vietnam War. This particular M41A3 of the ARVN 1st Cavalry Regiment has been modified with an AN/VSS-1 infrared searchlight and a shield in front of the commander's external .50-cal machine gun.

The M41 and M41A1 could successfully engage older tanks such as the T-34-85 frontally, but they had only marginal, short-range capability against contemporary Soviet tanks such as the T-54A. Shortly before M41 production ceased, the engineer teams at the Detroit Arsenal began development of a version of the M41 with a 90mm smooth-bore gun, called the T49, to deal with newer threats such as the Soviet T-54 medium tank. Although two prototypes were completed, no actual production took place.

As mentioned previously, the 1952 reorganization of the US armored divisions placed the bulk of the division’s M41s in the divisional reconnaissance battalion, with 30 tanks. The remaining 28 M41 tanks were scattered as reconnaissance tanks among the division’s other battalions. The shift to the “Pentomic” organization in 1957–59 dropped the total number of M41 tanks in an armored division to 54 tanks. The ROAD (Reorganization Objective Army Division) reorganization of 1962–64 had a more substantial impact. The total number of M41 tanks was reduced to 40: 18 in a divisional armored cavalry squadron, and two in each of the tank and mechanized infantry battalions. There were also substantial modifications within the armored cavalry units.

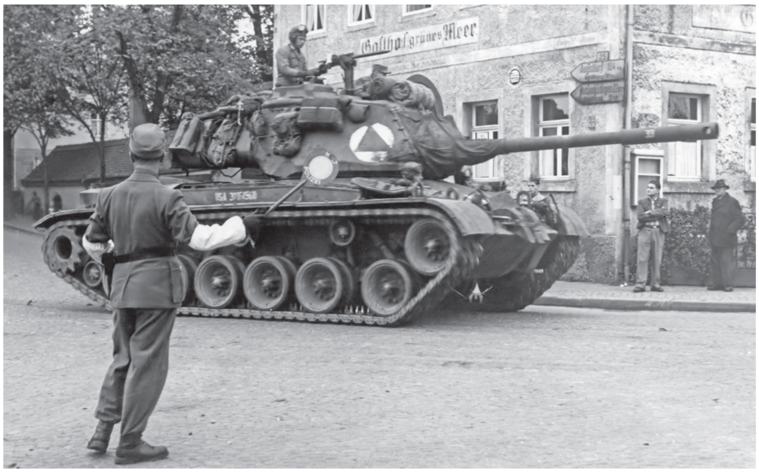
Of the 3,729 M41 tanks manufactured, 2,929 (79 percent) were exported through MDAP and other programs as detailed in the accompanying chart. The M41 series was popular in the Asia–Pacific region and South America where the road networks could not easily support heavier tanks such as the M47 or M48 Patton tanks. The M41 tank never saw combat service in American hands but was used in a number of conflicts, most notably by the Army of the Republic of Vietnam (ARVN) during the Vietnam War.

Export of the M41 76mm gun tank

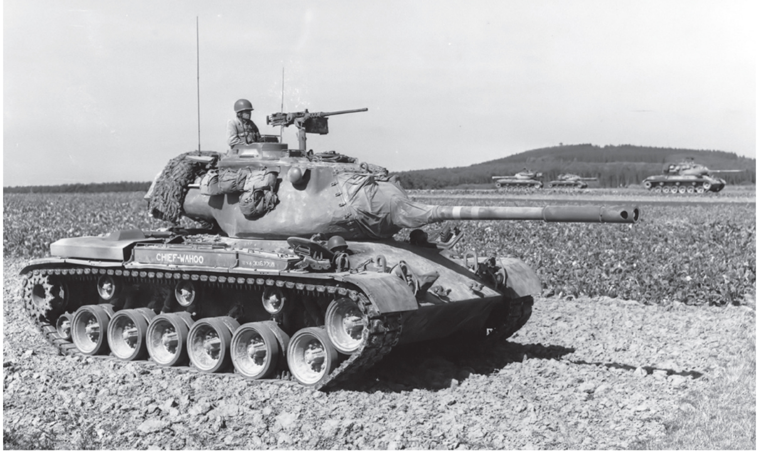
Country	M41	M41A1	M41A2	M41A3
Argentina				50
Austria	42			
Belgium	84	110		
Brazil	40		83	165
Chile				50
Denmark		53		
Ecuador				25

Ethiopia	27	27		17
Greece				100
Iran		42		
Japan	147			
Lebanon	18			
Netherlands		50		
New Zealand		10		
Philippines	7			
Portugal		1		
Saudi Arabia	36	39		
Spain	38			140
Sudan				55
Taiwan	207	198	10	373
Thailand	93	34	2	41
Tunisia	14	5		
S. Vietnam				506
Total	753	569	95	1,522

As was the case with the M24 light tank, the M41 chassis was used as the basis for a family of combat vehicles. These included the M8 High-Speed Tractor, the M42 40mm Self-Propelled Anti-Aircraft Gun, the M44 155mm self-propelled howitzer, the M52 105mm self-propelled howitzer, and the M75 armored personnel carrier. Production of the M41 tank derivatives far-outstripped production of the tank version, with 5,594 manufactured compared to 3,729 M41 tanks.



An M47 of the 57th Medium Tank Battalion supporting the 12th RCT of the 2nd Armored Division in the town of Dinkelsbühl during Exercise Cordon Bleu on October 13, 1955. Aggressor forces during this period carried the green and white "Circle Trigon" insignia.



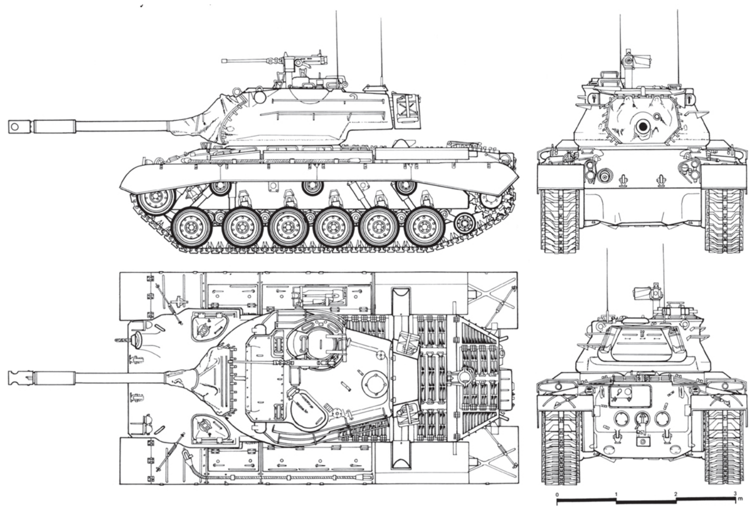
An M47 named "Chief-Wahoo" from the 57th Tank Battalion, 2nd Armored Division, during Exercise Monte Carlo in September 1953. This was the first in-depth NATO wargame to experiment with atomic warfare and involved 120,000 US, 27,000 Belgian, 22,000 French, and 6,000 British troops.

THE M47 PATTON 90MM GUN TANK

Due to the shortage of M26/M46 medium tanks at the start of the Korean War, the US Army wanted to accelerate medium tank production. The new T42 medium tank development effort was underway, but it was expected to take several more years before production could begin. As an expedient, in July 1950 the Army decided to adopt the advanced turret and fire controls of the T42 but mount them on the existing M46 tank chassis as the M47 90mm gun tank. The program was especially hasty, and no prototype or pilot model would be built for testing before mass production began. Some improvements were introduced into the M46 chassis, including the engine cooling system, electrical harness, and the glacis plate.

Since it would take some time to begin manufacturing the T42/M47 turret, new production began of the M46A1 Patton that incorporated the powertrain improvements of the M47. A total of 370 of these were completed by April 1951, the first serial manufactured US tanks since 1945.

Manufacture of the M47 began in May 1951 at the Detroit Arsenal, with the first ten tanks delivered by July. The M47 was subsequently produced by the Chrysler Corporation, ALCO (American Locomotive Company), GMC's Fisher Body Division, and the Ford Motor Company.



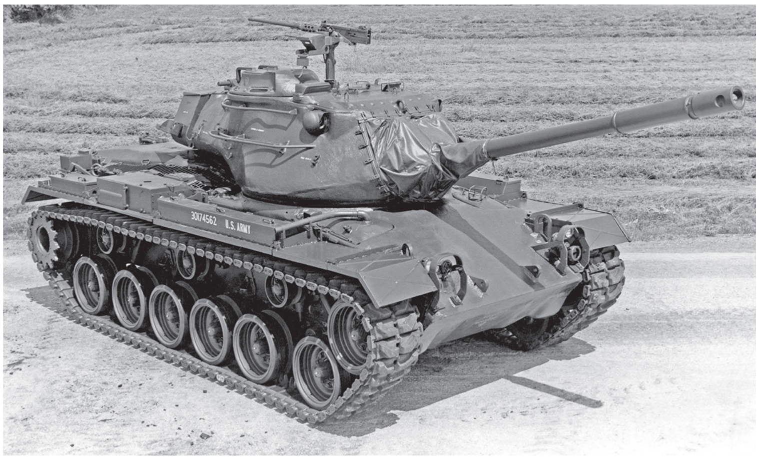
M47 90mm tank. (Author)

The initial batches of M47 tanks had so many technical flaws in the new turret that they were withheld from deployment. After undergoing numerous modifications during production, the Army Field Forces finally accepted the M47 tank for deployment. The first M47 tanks were delivered to Seventh Army in Germany in May 1952. By the end of 1952, Seventh Army had all its 1,640 authorized M47 tanks in place and had rebuilt 988 older M26 tanks for transfer to France, Belgium, and Italy. However, the M47 remained very troublesome in service, with lingering mechanical issues.

Technical problems continued to plague the M47 after deployment to Army units in Europe. During 2nd Armored Division maneuvers in the autumn of 1953, 89 (30 percent) of the division's 274 M47 tanks experienced drive failures, and a subsequent inspection revealed that another 109 drives (40 percent) could be expected to fail soon. Early in November, Seventh Army commander Lt. Gen. Anthony McAuliffe wrote Gen. Ridgway, the new Army Chief of Staff:

> This tank was rushed into production with what I consider inadequate service tests. I think the lesson is clear that, for such a complicated mechanism, thorough testing must always take place before the initiation of quantity production… I am very concerned about the repercussions which appear bound to follow when issue of this tank is made to our allies.

The career of the M47 tank in the US Army was short-lived, with nearly all M47 tanks being transferred to allied armies. This is an M47 in service with the Austrian army with an infrared searchlight added.



In the late 1970s, BMY developed an upgrade kit for the M47 called the M47M. This substituted the AVDS-1790 diesel for earlier engines as is evident from the new engine deck. This conversion program was undertaken in Iran, with some M47 tanks of the Pakistan army also undergoing this upgrade.

Gen. Ridgway replied to McAuliffe that corrective measures were underway and that the drive weakness “stems from an original design so marginal that ordinary manufacturing methods do not produce parts meeting required specifications.” By the summer of 1952, many Army leaders had become convinced that the compressed development/acquisition process, although perhaps justified as an emergency measure, had so many negative consequences it must be avoided in the future. Ordnance acknowledged that the overlapping stages in the development and production cycle should have been sequential stages and not concurrent.

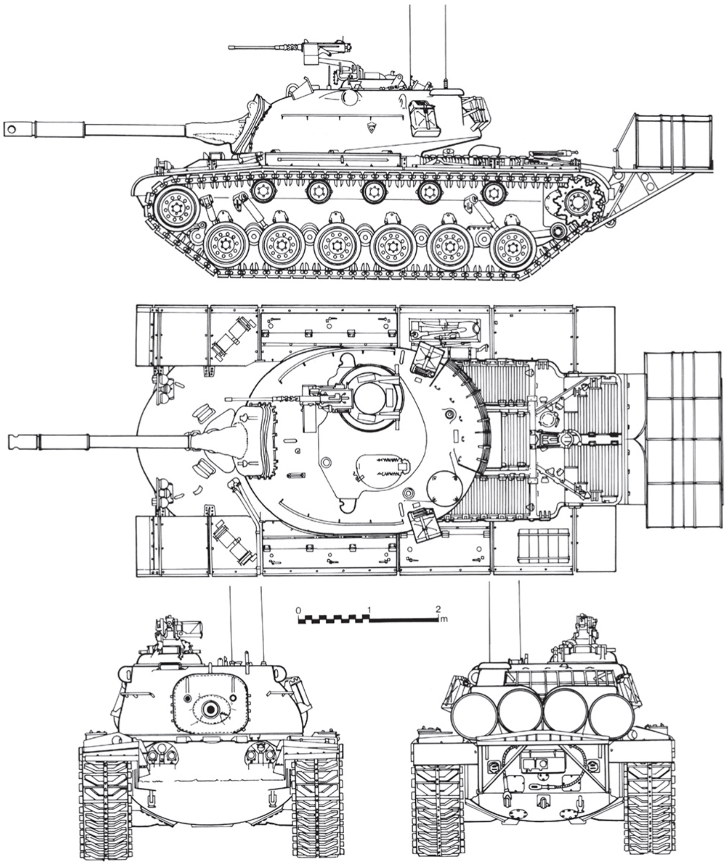
M47 tank production was completed in November 1953. Due to its close relation to the M46, the Army decided to keep the “Patton” name for the M47, and it was occasionally referred to as the Patton 47 or Patton II. The US Marine Corps began deploying the M47 in October 1953, but its service was short-lived when it was replaced by the M48A1 in 1959.

In October 1951, NATO agreed to adopt the British Centurion and the American M47 as its standard tank. The first M47s delivered under the Mutual Security Agency program went to Belgium in June 1952. After the US Army M47 tanks were corrected, nearly all of these tanks were transferred to allied armies through the MDAP program. Of the

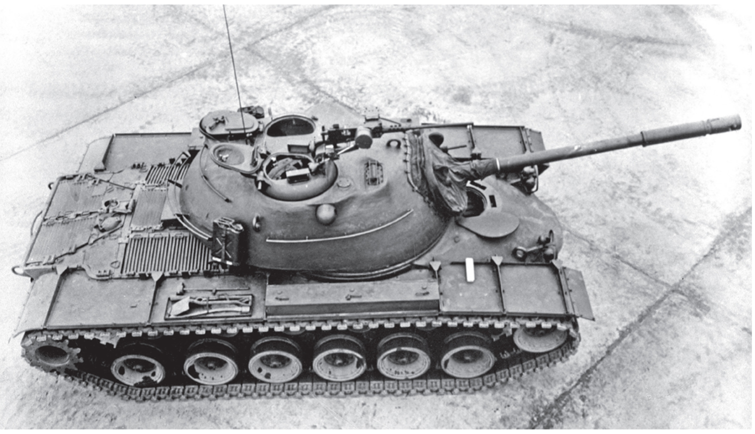
8,576 M47s manufactured, 8,552 (99.7 percent) were transferred to other armies, and the type virtually disappeared from US Army service by the late 1950s. The M47 formed the backbone of the NATO tank force for nearly 15 years.

M48 PATTON III 90MM GUN TANK

Since the M47 was regarded as an expedient design due to the Korean tank crisis, an interdepartmental conference in October 1950 recommended the initiation of a program for a more refined design. Analysis of tank engagements that had taken place in the summer of 1950 in Korea concluded that the side firing the first shot would have a 70 percent probability of success. As a result, the primary design objective of the new T48 tank was an advanced fire control system to permit an earlier engagement of enemy tanks at longer ranges. This system consisted of a stereoscopic rangefinder, mechanical ballistic computer, ballistic drive, and periscope for the gunner. Although the M47 had a rangefinder, the T48's mechanical computer could adjust for ballistic influences imparted by vehicle cant and different types of ammunition. Furthermore, the computer was linked to the ballistic drive that automatically elevated the gun.

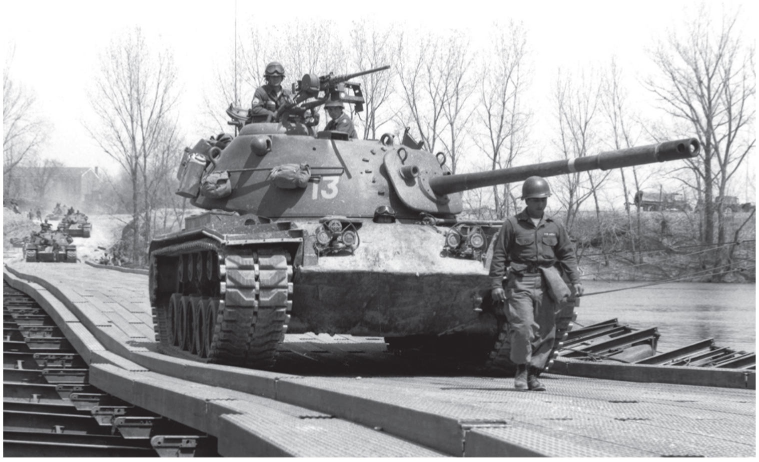


M48 90mm tank. (Author)

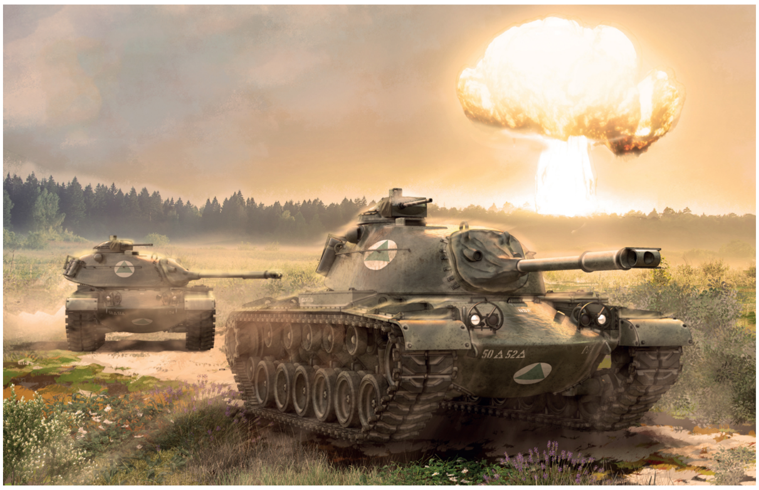


The baseline M48 tank had an exposed .50-cal machine-gun mount on the commander's cupola as seen here. This gave way to an enclosed machine-gun cupola on the subsequent M48A1 and M48A2.

The other T48 tank requirements included the T139 90mm gun, a wider 85-inch-diameter turret ring, reduced ground pressure, and increased armor. The aim was to employ the existing M46/M47 powertrain, but to develop a new cast hull with better ballistic shaping. This was strongly influenced by ongoing design work on the T43 heavy tank. The hemispherical turret was simpler in shape than the M47's turret and was probably influenced by Soviet designs such as the IS-3 heavy tank.



The M48A1 was the preferred tank for the US Army in Europe, and so most M48s served in CONUS (Continental US), such as this tank of 66th Armor at Fort Campbell, Kentucky, on April 13, 1960, crossing a floating bridge erected over the Cumberland river during Exercise Quick Strike.



A pair of M48A1 tanks of 1/14th Armored Cavalry, on Exercise Cordon Bleu in Germany, October 1955, with a simulated nuclear explosion in the background. (Artwork by Felipe Rodríguez © Osprey Publishing)

An M48A1 of the Tank Company, 1/14th Armored Cavalry, in the village of Feuchtwangen on October 14, 1955, taking part with the aggressor forces during Exercise Cordon Bleu. This was the first large NATO exercise in which the M48A1 took part.

An M48A1 with M8 dozer blade of the 3/35th Armor clears rubble from a street in Beirut on October 9, 1958, during the US intervention in Lebanon.

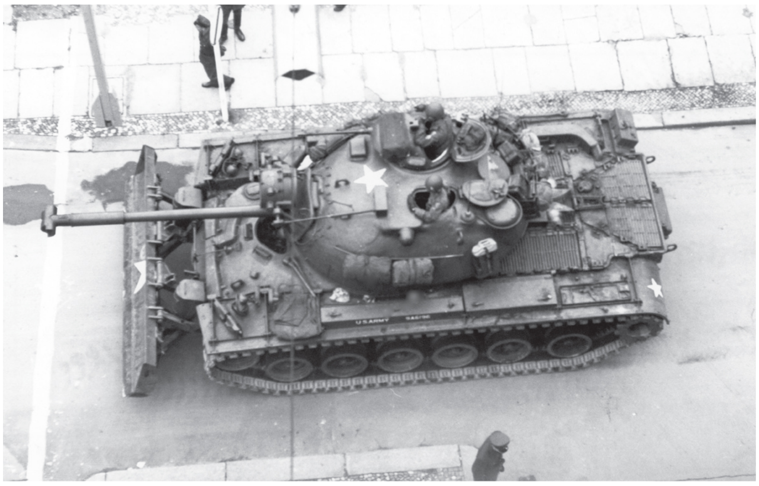
Chrysler was given a contract on December 22, 1950, to proceed with the T48 design effort followed by preliminary production contracts to Ford and Fisher Body in March 1951. As in the case of the M41 and M47, the program was highly compressed, with development taking place alongside preliminary production. The first T48 pilot was completed in December 1951 and entered tests at Aberdeen Proving

Ground in April 1952 at the same time that production began. Deficiencies in the tank, involving many of the same turret control problems as the M47, delayed widespread deployment of the T48. The first production tank rolled off the assembly lines in April 1952 from the new tank plant at Newark, Delaware. The T48 was standardized as the M48 90mm gun tank in April 1953 and occasionally called the Patton 48 or Patton III. By mid-1953, 2,294 M48 tanks had been manufactured, but it was still undergoing testing and design changes. It had not yet been approved for issue to overseas units. Production was supposed to total 9,000 M48 tanks by July 1954, but this was significantly trimmed back. This was in part due to the serious technical problems in the original production batches, as well as the arrival of the Eisenhower administration in 1953, which had a less frenzied view of the world situation. The M48 was introduced into service with the 2nd Armored Division in Germany in 1953.

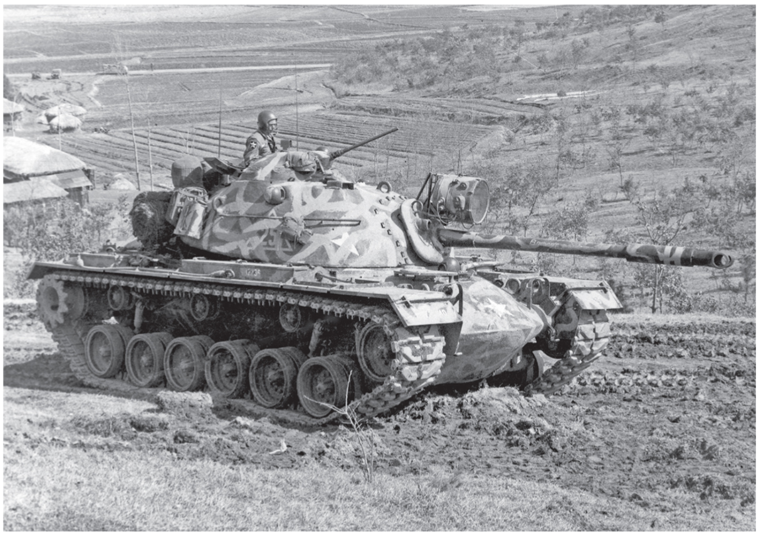
While basic technical flaws were still being rectified, a number of upgrades were developed. The M48 had an externally mounted .50-cal machine gun. The new enclosed M1 cupola was developed, which permitted the tank commander to operate the .50-cal machine gun from under cover. This was not simply for ballistic protection. The US Army was beginning to consider the technical aspects of a nuclear battlefield, and an enclosed cupola was an initial effort in this direction. This was adopted on the new M48A1 tank. The M48A1 was the preferred version for US tank units in Europe and began to be deployed with USAREUR in 1955. As a result, in 1955 the older M47 tanks were reclassified as “limited standard.”

One of the main drawbacks of the M47/M48 series was its poor fuel economy. To extend the range of the M48, tanks were fitted with a jettisonable fuel tank system at the rear which could carry four unprotected 55-gallon fuel drums. A better solution was the development of the AVI-1790-8 engine, which introduced engine fuel injection as well as a streamlined cooling system that provided more space for internal fuel. This was adopted on the new M48A2 in late 1955 with a production run of 2,328 tanks.

During the production run of the M48A2, it was decided to replace the troublesome M13A1 stereoscopic rangefinder with a more easily operated M17C coincidence rangefinder. This feature, along with other fire control improvements, was adopted on the M48A2C. The only external difference between this variant and the earlier M48A2 was the absence of a small return roller between the last road wheel and the drive sprocket. A total of 1,344 of the previous M48A2 tanks were upgraded to the M48A2C standard in 1959. The M48A2 was relatively uncommon in the US Army, since by 1959, the production of the next-generation M60 had already begun. Of the 421 M48A1 tanks obtained by the Marine Corps, 419 were upgraded as M48A2 tanks with diesel engines in 1963–64. Of the 2,328 M48A2 tanks manufactured, 2,149 (92.3 percent) were provided to allied armies, notably to Germany, Turkey, and Korea.



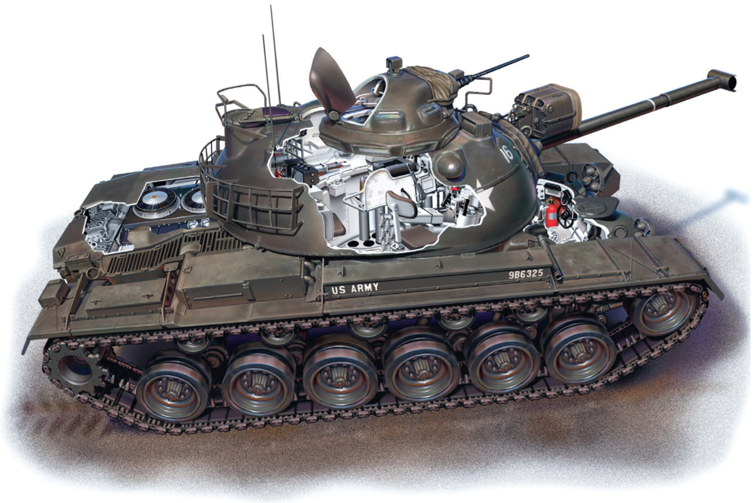
An M48A1 tank of Co. F, 40th Armor, of the Berlin Brigade on Fredrichstrasse near Checkpoint Charlie during the Berlin Crisis of October 1961. This tank is fitted with the M8 dozer blade and an 18-inch Crouse-Hinds Model 44676-C incandescent searchlight.



An M48A1 from Co. A, 3/40th Armor, 1st Cavalry Division, during a training exercise in South Korea in 1962. It is also fitted with an 18-inch Crouse-Hinds Model 44676-C incandescent searchlight.

With M60 tank production about to begin, in 1959 the Army decided to upgrade older M48A1 tanks. Designated M48A3, these conversions featured the AVDS-1790 diesel engine as well as the improved fire controls of the M48A2. The conversions were undertaken at the Anniston and Red River Army Depots from February 1963 to late 1964. They can be distinguished from the very similar M48A2 by their top-loading air cleaners on the rear of the fenders. The Army received 600 M48A3 and the Marines 419. As a result, by 1965 no M48A1 tanks were in active-duty US units. Due to the success of the program, on April 14, 1967, BMY received an Army contract to convert 578 more M48A1 tanks into M48A3s, and the conversion program concluded in 1969. This brought the total of M48A3 conversions to 1,597. Toward the end of the conversion program, the final batch of vehicles, called M48A3 (Late Model) or M48A3 Model B, had additional improvements, including hydraulic brakes, improved steering, an inflatable turret seal, and metal screening on the rear turret stowage bin. The most distinguishable feature of these upgrades was the use of a G305 turret cupola vision riser that offered the tank commander full 360-degree vision. These vehicles were in the 601W to 726W serial number range.

The M48A3 series is best known for its combat use in Vietnam, where it was the predominant US tank type. This is detailed later in this book. Following the withdrawal of the last US tank and armored cavalry units from Vietnam in 1972, all active-duty Army tank units were equipped with the M60 tank series, while reserve units had M48A2C/A3 or M60 series tanks.



M48A3 90mm Patton tank, 69th Armor, 4th Infantry Division, Vietnam, 1968. (Artwork by Jim Laurier © Osprey Publishing)

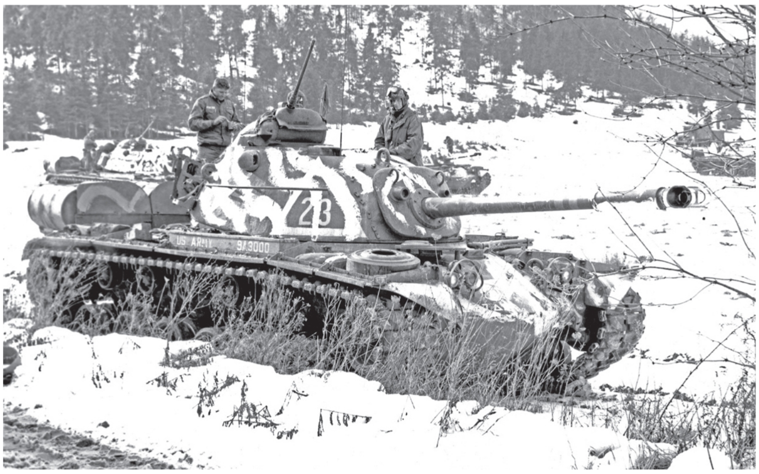
Comparative technical data of Patton tanks

Designation	M47	M48A1	M48A2	M48A3	M48A5
Crew	5	4	4	4	4
Loaded weight (tons)	50.9	52	52.5	52.5	52.5
Length overall (in)	335	347	342	342	372
Width (in)	138	143	143	143	143
Height (in)	131	122	122	122	128
Glacis armor (mm)	102	110	110	110	109
Turret mantlet armor (mm)	114	114	114	114	127
Turret side armor (mm)	64	76	76	76	140
Main gun type	M36	M41	M41	M41	M68

Gun caliber (mm)	90	90	90	90	105
Elevation (degrees)	-10 +15	-9 +19	-9 +19	-9 +19	-10 +20
Rounds stowed	71	60	64	62	63
Co-axial MG (mm)	7.62	7.62	7.62	7.62	7.62
Rangefinder	stereo	stereo	stereo	coin	coin
Computer	no	no	no	no	M13A2
Stabilization	no	no	no	no	no
Engine	AV-1790-5B	AV-1790-5B	AVI-1790-8	AVDS-1790-2A	AVDS-1790-2A
Engine type	gas	gas	gas	diesel	diesel
Horsepower	810	810	825	750	750
Transmission	CD-850-4	CD-850-4A	CD-850-5	CD-850-6A	CD-850-6A
Road speed (mph)	30	28	30	30	30
Max. range (mi)	80	70	160	300	300
Fuel (gal)	232	200	335	385	385

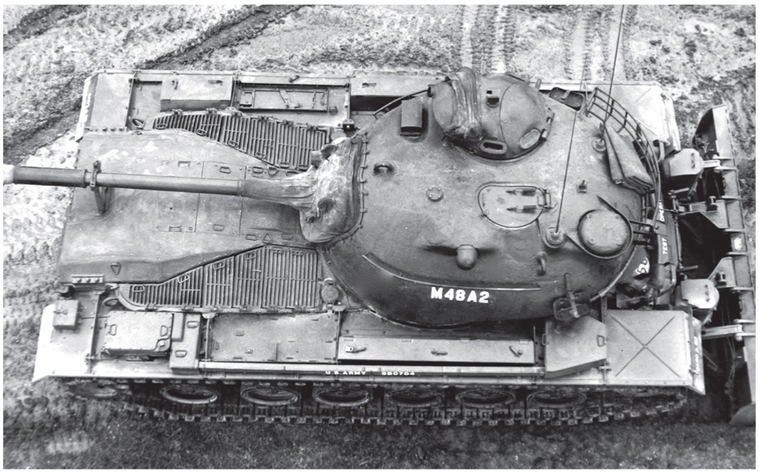
OPERATING THE M48 PATTON TANK

Compared to earlier medium tanks, the M48 introduced completely redesigned driver's controls, more like those of an automobile than the older style of tractor controls. Steering was by means of a steering wheel, and gear changing was done with a gear lever attached to the steering column on the right side. Although these controls necessitated a sophisticated transmission, they permitted an ease of driving unmatched in any other tank of the period, and training was greatly simplified. The steering system also proved a great deal more reliable than earlier hand-levered brake steering, even though the system was more complicated.



A snow-camouflaged M48A1 of Co. A, 3/40th Armor, 1st Cavalry Division, in the Republic of Korea in 1962. Due to the poor fuel economy of the early Patton tanks, they were often fitted with the Universal Jettison Fuel Tank Kit on the hull rear that enabled them to carry four 55-gallon fuel drums.

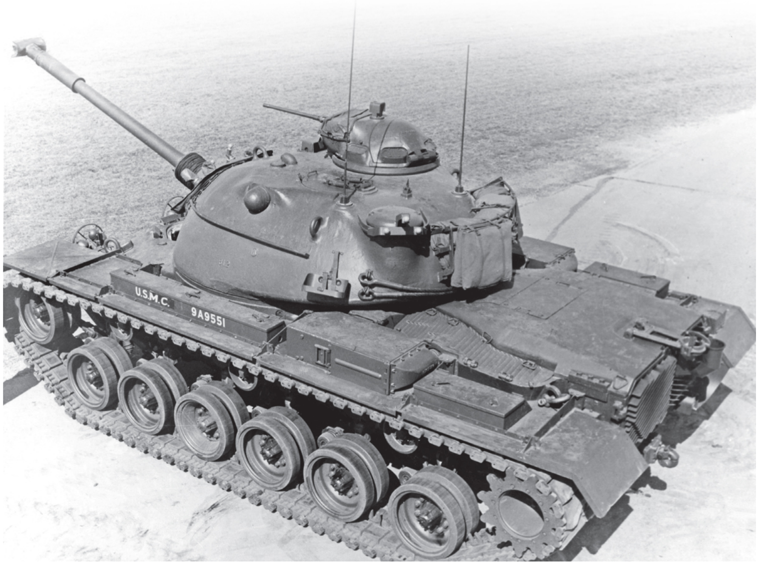
A major difference between the turret controls of the M47 and M48 was that the M47 gunner controlled the rangefinder, while in the M48 series, it was the commander. The gunner sat in the right forward half of the tank turret with the tank commander immediately behind him and the loader on the other side of the gun in the left half of the turret. The gunner's controls were located on a fire control assembly with a right-handed pistol grip. The operation of the hydraulic turret traverse was accomplished by turning the pistol grip clockwise for a right traverse, and counter-clockwise for left traverse. Moving it down or up elevated and depressed the gun. The use of hydraulic traverse in the M48 in place of earlier mechanical or electrical drives gave it the fastest turret traverse of its day, though the system required more maintenance. There were manual controls at the left of assembly in case the hydraulic system failed. To the right of the fire control assembly was an azimuth indicator to show the gunner the direction in which the turret was pointed relative to the rest of the tank, and behind this was the ballistic computer.



The M48A2 introduced the fuel-injected AVI-1790-8 engine to the Patton series, accompanied by a new engine deck with less extensive grating than the previous M48A1. This particular example is the pilot for the dozer version, fitted with the M8 dozer blade. There were 12 dozer tanks assigned to the engineer battalions of the armored divisions in the early 1960s.

The gunner's main sight was a 6x-power periscope with illuminated reticles, but a secondary telescopic sight, not linked to the computer or rangefinder, was also provided. The tank commander had a control handle very similar to that of the gunner, and he could override the gunner's control to traverse the turret and elevate the gun. On the M48 series, the tank commander was responsible for operating the optical rangefinder and was provided with a separate periscopic sight for surveillance.

The loader stood or sat on the other side of the breech, and in front of him was the co-axial machine gun and its ammunition stowage and feed system. The different variants of the M48 series carried slightly different amounts of the 90mm main gun ammunition: M48 – 60; M48A2 – 64; M48M3 – 62. To the left of the driver were 19 rounds in tubular racks, and to his right a further 11 rounds. There were 16 rounds stowed vertically in front of the loader on the basket side, eight rounds in a bin on the floor, and eight more behind the loader in the rear turret bustle. The M41 90mm gun in the M48 series could fire a wide range of ammunition types and this is discussed in more detail later in this book.

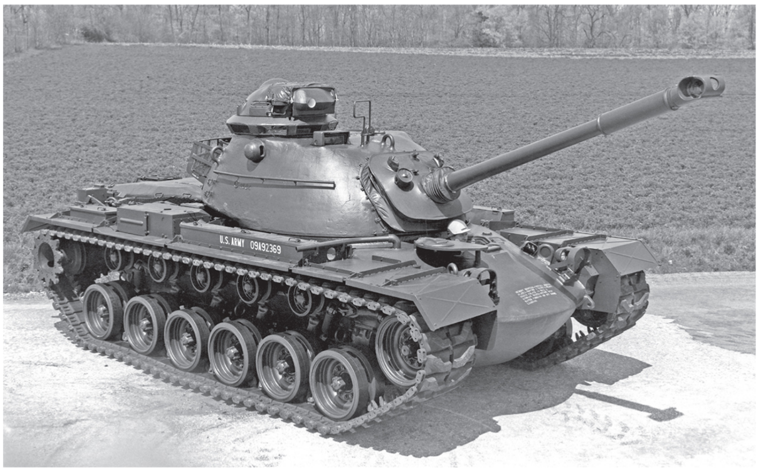


From February 1963 to late 1964, the Anniston and Red River Army Depots upgraded 1,019 older M48A1 tanks with the AVDS-1790 diesel engine and the improved fire controls of the M48A2. The resulting tank was designated as the M48A3. It can be distinguished from the very similar M48A2 by its top-loading air cleaners.

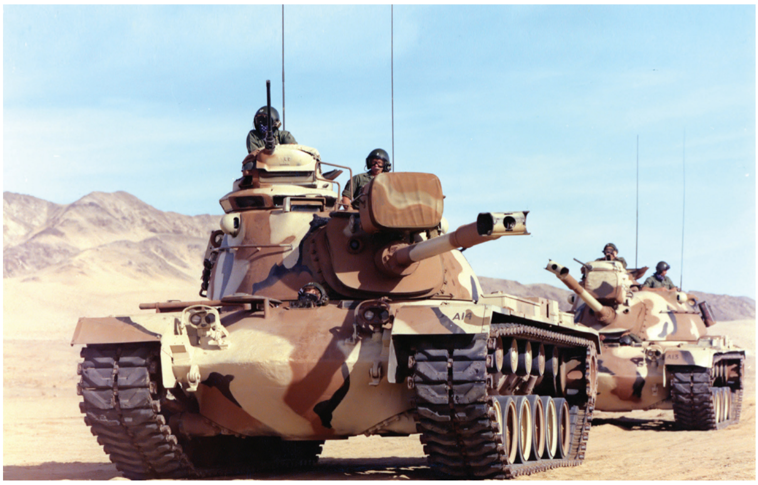
A typical firing sequence against an enemy tank would take place as follows. The tank commander would spot an enemy tank through his 6x-power periscope, and using his control grip, swing the turret to engage the target. Instructing the driver to stop, through the earphones and intercom, he would turn over the turret controls to the gunner and instruct the loader what type of ammunition to chamber. On hearing these instructions, the gunner would actuate the ballistic computer handle to select the correct type of ammunition, and would disengage the super-elevation crank until the tank commander had made the ranging adjustments. The tank commander would switch to the 10x-power optical rangefinder, make the ranging measurements with the proper controls, and inform the gunner that he was finished. The gunner would reactivate the super-elevation crank, which would automatically result in the range information being transmitted by mechanical linkage to the ballistic computer. The computer in turn would depress the gun line of sight in the gunner's periscope, necessitating the gunner to elevate the gun barrel to put the target back into the crosshairs. This procedure put the proper amount of super-elevation into the gun, and the gunner would fire. The whole operation took about 15 seconds and gave about a 50 percent probability of a first round hit at 1,500 meters. While this process was complex, it offered a level of accuracy that was truly remarkable for its day.

During close-range engagements the system was not used, with the crew either substituting manual input of an estimated range, or simply using the co-axial machine gun for ranging and targeting for a faster response.

The main drawback of the original stereoscopic rangefinder was the skill required to operate it. Each commander had to set the diopter and inter-pupillary scales to match his own eyesight, and over 20 percent of crews did not have adequate vision to use the rangefinder properly. To speed the operation, the tank commander could set the range knob for the estimated range. When first looking into the sight the tank commander would see two illuminated reticle patterns in a V-shape. Using his controls, the two V-shapes had to be superimposed – a procedure known as “flying the geese.” In spite of training programs and the great potential of the system, results of the fire controls in actual use were often disappointing. In the mid-1950s the US Army decided to adopt coincidence optical rangefinders instead. First used on the M48A2C, these required more light to operate properly and were marginally less accurate, but they were a great deal easier to use. With a coincidence rangefinder the target appears as a ghost image to the left and a true image to the right. When both images are superimposed, the proper range has been found, in much the same fashion as photographic cameras are focused.



The final conversion batch of M48A1 into M48A3 in 1967–69 by BMY was sometimes called M48A3 (Late Model) or M48A3 Mod. B. It had a variety of improvements over the previous M48A3 conversions, the most identifiable of which was a G305 turret cupola vision riser under the commander's usual machine-gun cupola.

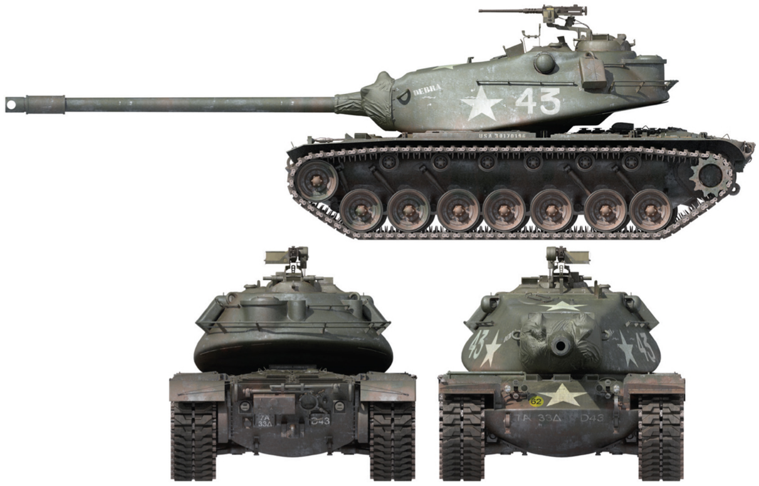


A column of Marine M48A3 Mod. B tanks of Co. B, 4th Tank Battalion, on exercise at 29 Palms, California, on April 1, 1976. The tanks are fitted with the AN/VSS-1 infrared searchlight, though in this view, a canvas cover protects the lens. These tanks are painted in the MERDC camouflage scheme using the desert variation of the modular camouflage system.

M103 120MM GUN TANK

Due to concern over the Soviet IS-3 heavy tank, the Army initiated the T43 heavy tank program in 1948 with the strong backing of the US

Marine Corps. It was armed with a new 120mm gun, deemed sufficient to deal with the Soviet heavy tank threat. The T43 pilot was delivered for testing at Aberdeen Proving Ground in June 1951.

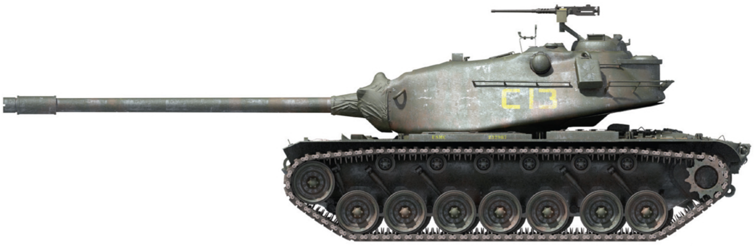


M103 120mm tank, 1957 initial model. (Artwork by Richard Chasemore © Osprey Publishing)

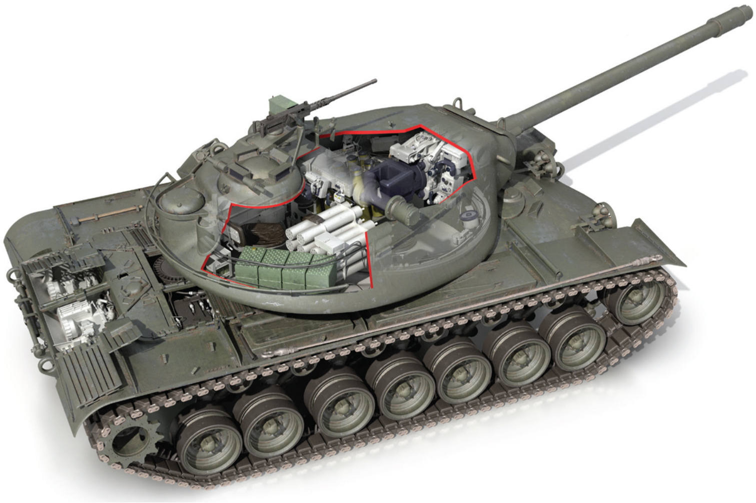
The need for such a large and heavy vehicle came into question in 1950 due to the development of new 90mm HEAT ammunition that apparently could defeat existing Soviet tank armor without recourse to the 120mm gun. In response, the US Army ordered only 80 of the new T43 120mm gun tanks, while the Marines ordered 220. As was the case with many of the designs rushed into production during the Korean tank panic, the resulting vehicles were deemed unsatisfactory and remained in depot storage until 1956, when the Army standardized the design as the M103. The Army deployed 72 M103 tanks with the 899th Heavy Tank Battalion in Germany in late 1957.

The Marine Corps was still not satisfied with the baseline M103 tank as it did not satisfy the original turret and gun fire control requirements. In April 1954, the Army began the T43E2 upgrade program. The pilot arrived at Aberdeen Proving Ground in February 1956 and testing continued for a year until February 1957. The resulting M103A1 was ready in July 1959, and the Marine T43E1 tanks were rebuilt to this standard. The Army subsequently requested the loan of 72 M103A1s from the Marines to re-equip their sole M103 battalion in Germany, which in the meantime had been redesignated as the 2nd Heavy Tank

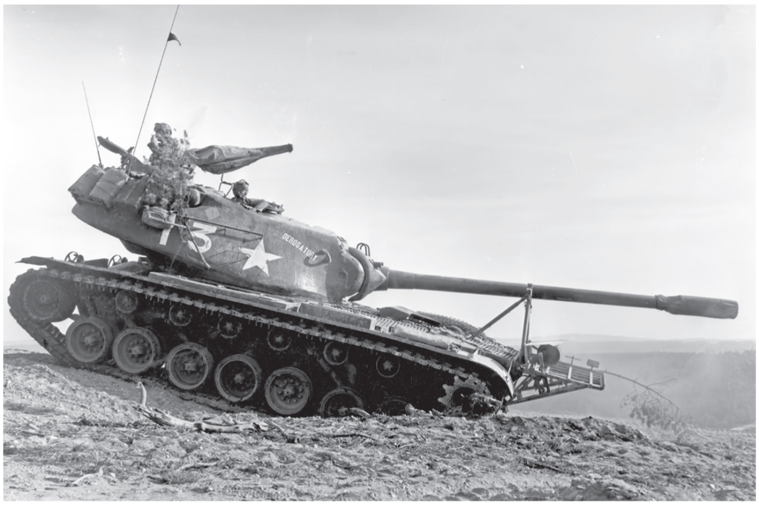
Battalion, 33rd Armored Regiment. This loan ended in 1963 when the M103A1 tanks were returned to the Marines, also ending the deployment of the M103 120mm gun tank in the US Army.



M103A1, US Marine Corps, 1963. (Artwork by Richard Chasemore © Osprey Publishing)



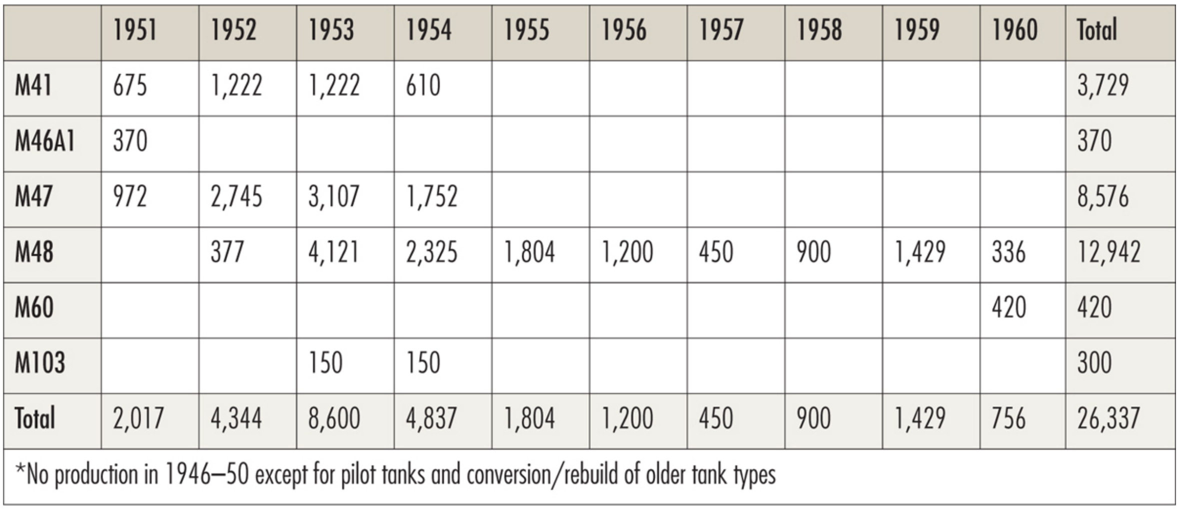
M103A1 120mm tank. (Artwork by Richard Chasemore © Osprey Publishing)



An M103 tank named "Derogatory," with its turret in travel position and the gun locked to the rear at the Grafenwöhr gunnery range in September 1959. This tank belonged to the only US Army M103 unit, the 2nd Heavy Tank Battalion, 33rd Armored Regiment, 3rd Armored Division. The frame projecting from the rear of the tank was designed to carry additional fuel drums.

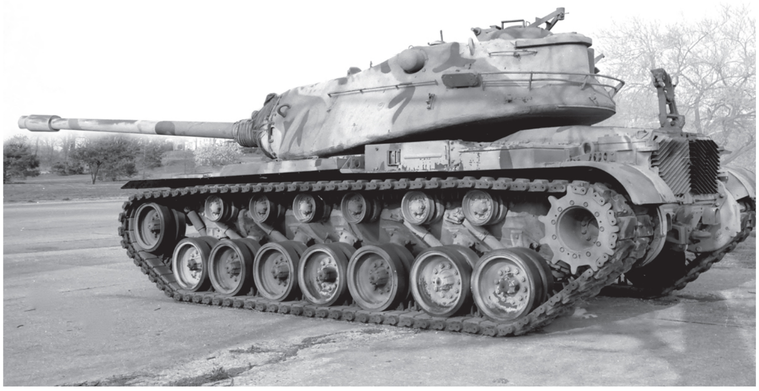
As was the case with the M48, the Marines desired the better fuel economy possible with a diesel engine, and an upgrade effort began in June 1961. A pilot M103A1E1 was rebuilt with the AVDS-1790-2A that had been developed for the new M60 tank and arrived at Aberdeen Proving Ground in March 1962. A total of 153 Marine M103A1 tanks were rebuilt to the M103A2 configuration starting in November 1962 at the Red River Army Depot.

US tank production, 1951–60*

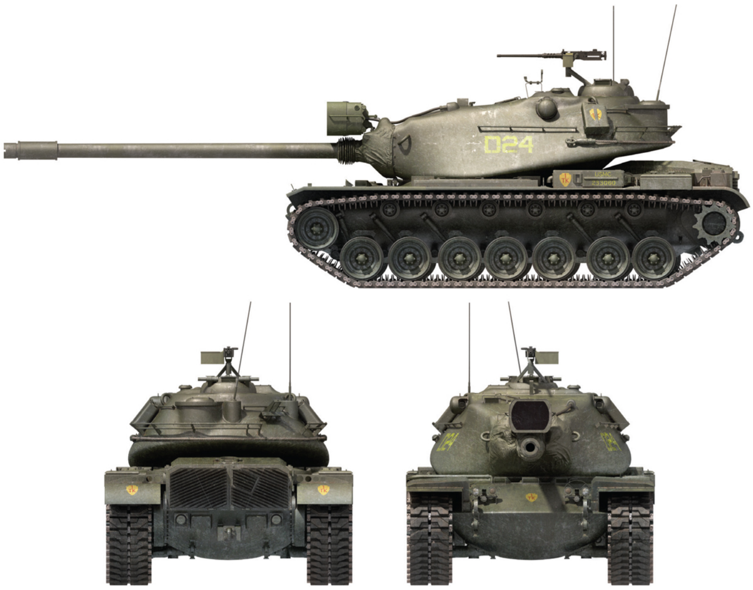


	1951	1952	1953	1954	1955	1956	1957	1958	1959	1960	Total
M41	675	1,222	1,222	610							3,729
M46A1	370										370
M47	972	2,745	3,107	1,752							8,576
M48		377	4,121	2,325	1,804	1,200	450	900	1,429	336	12,942
M60										420	420
M103			150	150							300
Total	2,017	4,344	8,600	4,837	1,804	1,200	450	900	1,429	756	26,337

*No production in 1946–50 except for pilot tanks and conversion/rebuild of older tank types



The Red River Army Depot rebuilt the Marine Corps M103A1 fleet into the new M103A2 configuration in 1962 with the AVDS-1790-2A diesel engine as used on the M60 tank series. This led to a different rear and engine deck as can be seen here.



M103A2, US Marine Corps, 1972. (Artwork by Richard Chasemore © Osprey Publishing)

THE NUCLEAR BATTLEFIELD

The US Army began studying the potential use of atomic weapons on the tactical battlefield in the late 1940s. The first nuclear-capable artillery, the M65 280mm gun, entered service in 1952, and the first test of its associated 15 kiloton nuclear projectile was conducted in May 1953. It took some time for the US Army to adapt to the nuclear battlefield due to the novelty of the concept as well as the relatively small number of tactical nuclear weapons in the arsenal until the late 1950s. The Atomic Field Army-1 demonstration program began in 1954 to examine what changes would be needed in equipment and tactics. These trials eventually resulted in the development of the "Pentomic" division, organized around five battle groups able to avoid decimation by enemy nuclear weapons by remaining dispersed and highly mobile.

The advent of the Eisenhower administration and the end of the Korean War in 1953 halted the Korean tank panic. Eisenhower was unwilling to compete with the Soviet Union in a conventional arms race due to its inevitable drain on the economy. Instead, he adopted the "New Look" national security policy that relied on nuclear weapons to deter Soviet aggression. This included not only strategic nuclear weapons aimed at the Soviet Union, but also tactical nuclear weapons aimed at the Soviet army in Europe. Eisenhower slashed funding on conventional forces; tank production plummeted. Instead, funding was shifted to nuclear-capable tactical missiles as shown in the accompanying chart. By the early 1960s, the US Army was spending about six times as much on missiles as on tanks and armored vehicles.

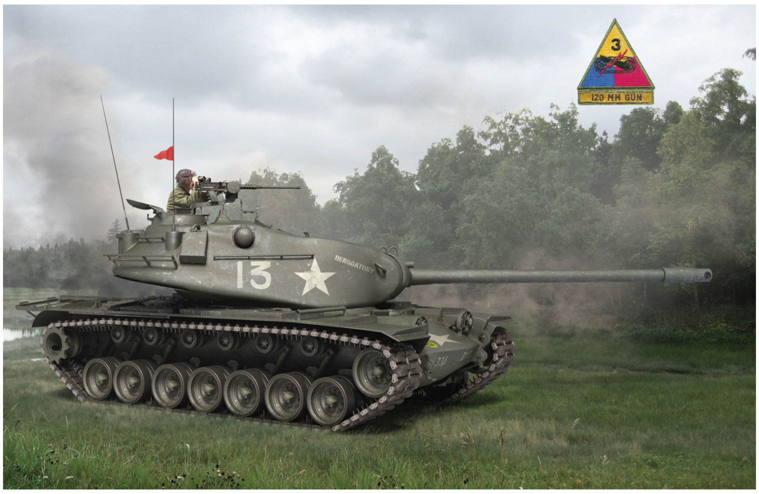
US Army tactical nuclear ballistic missile production

	1952	1953	1954	1955	1956	1957	1958	1959	1960	Total
Honest John		140	121	379	1,453	1,471	1,058	461	2,112	7,195
Corporal	21	129	131	132	279	158	128	108	131	1,217
Lacrosse						14	93	162	413	682
Total	21	269	252	511	1,732	1,643	1,279	731	2,656	9,094

The US Army in Europe remained relatively small as a result of the "New Look" doctrine. US doctrine was deliberately ambiguous. Was the US Army in Europe really expected to fight a protracted land war? Or was it merely a trigger to unleash Armageddon? Moscow could not be sure. Eisenhower was no stranger to strategic deception. The US Army's nuclear battlefield doctrine existed uneasily between wishful thinking and a belligerent bluff.

For example, Exercise Carte Blanche in 1955 included 355 simulated nuclear strikes; casualties were predicted to be 1.7 million dead and 3.5 million wounded in the first week of war. It was hard to see how any army could sustain combat operations under such a situation. A 1960 assessment of the US Army's nuclear battlefield doctrine concluded that "our surveillance means, communications, mobility, and firepower are inadequate to support this doctrine and will be for some time to come… I shudder to contemplate the outcome of engagements if we continue to practice the principles and train our men exclusively on a doctrine which is based on inadequate equipment or equipment of the future." Not surprisingly, the Pentomic division and much of its associated doctrine were abandoned in the early 1960s.

A less radical aspect of Eisenhower's "New Look" policy was the need for a well-equipped alliance to defend Europe. The German army was reborn as a key pillar of this approach. This also led to a revived tank transfer Mutual Defense Assistance Program that included new tanks such as the M41 and M47.



M103A1 of 2/33rd Armor, 3rd Armored Division, on maneuvers in West Germany, 1959. (Artwork by Richard Chasemore © Osprey Publishing)

US tank transfers in Europe*

	M24	M41	M41A1	M41A3	M4	M47	M48	M48A1	M48A2
Austria	69	42				153			
Belgium		84	110			784			
Denmark	63		53						
France	587				2,117	856			
Germany		50				1,120		233	1,463
Greece	156				67	275	673	167	
Italy	518				396	2,302			
Norway	123						38		
Netherlands	31		50		37				
Portugal	12		1		6	123			
Spain	31	38		17		489	65	66	
Turkey	238				3	980	1,948	350	404
Total	1,828	214	214	17	2,626	7,082	2,724	816	1,867

*Through September 30, 1982

EVOLUTION OF EARLY COLD WAR TANK GUN AMMUNITION

The power of tank guns in the 1950s was heavily dependent on the ammunition rather than caliber of the gun. During World War II, tank guns primarily relied on armor-piercing-capped (APC) projectiles, or the related APCBC (APC with ballistic cap). These proved to be deficient in penetration of thick, well-sloped frontal armor such as the wartime German Panther tank. The standard US M318 90mm APCBC round of the early 1950s could penetrate the T-54A turret only at ranges of 350 meters or less and could not penetrate the glacis plate at any range.

The shortcomings of the typical APC projectiles in the late 1940s led to the development of high-velocity projectiles with a sub-caliber penetrator. The most common type was the armor-piercing, composite rigid (APCR), also called high-velocity armor piercing (HVAP) by the US Army. This consisted of a sub-caliber penetrator, made of heavy, dense metal such as tungsten-carbide, encased in a lightweight aluminum shell. The penetrating power of kinetic energy projectiles such as these is more dependent on speed than projectile weight as is evident from the traditional equation ($\text{energy} = \frac{1}{2}\ \text{mass} \times \text{speed}^2$). The lighter weight of the APCR enables it to travel at higher speeds than a comparable APC round, and therefore it offered superior penetration.

The second type with a sub-caliber penetrator was called HVAPDS by the US Army in the 1950s. This consisted of a similar sub-caliber penetrator, but instead of being encased in a lightweight shell, the penetrator was held in place in the gun tube by a metal sabot that separated from the projectile after leaving the gun. Due to the higher speed of the APDS vs. APCR, it offered better penetration. However, the wartime APDS round suffered from severe dispersion problems at longer ranges, probably due to erratic separation of the sabot petals from the penetrator after leaving the barrel. These dispersion problems were overcome in the 1950s, with the US 90mm HVAPDS having a 50 percent probability of hit at 2,000 yards.

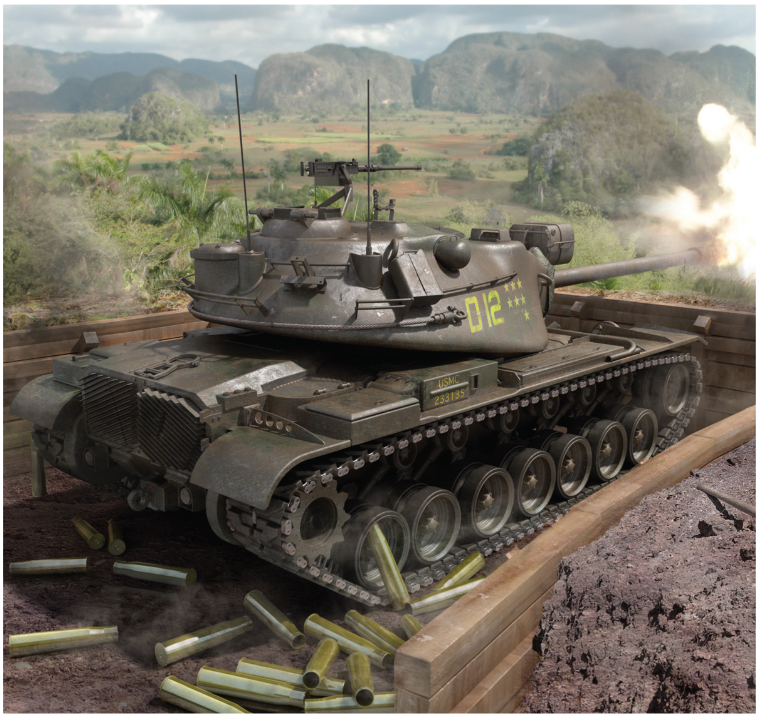
Other projectile configurations were well underway in the early 1950s. Three new projectiles emerged: HEAT (high-explosive anti-tank); HEP/HESH (high-explosive plastic/high-explosive, squash-head); and APFSDS (armor-piercing, fin-stabilized, discarding-sabot).

Of these three, HEAT was the most mature and most significant in the 1950s. HEAT ammunition had emerged during World War II for low-velocity anti-tank weapons such as anti-tank rockets and howitzers. However, it was unsuitable for high-velocity tank guns until the late 1940s. A HEAT projectile differed from a normal high-explosive projectile in that the high-explosive was shaped around a conical, hollow, metal liner. When the shaped-charge warhead was detonated, the explosive blast was focused on the metal liner, compressing it into a hypersonic jet of particles that could penetrate a great deal of steel armor.

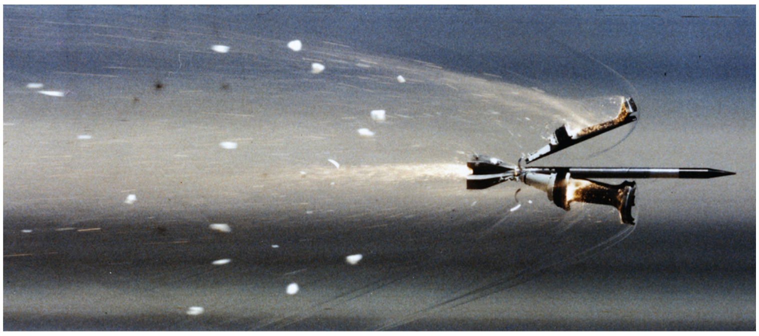
There were two reasons that World War II HEAT projectiles were ineffective in high-velocity tank guns. To begin with, tank guns of the period were rifled and imparted a spin on the projectile to help improve accuracy. However, the spin substantially degraded the hypersonic jet, decreasing its penetrating power. Second, the impact velocity of the tank guns was so fast that the shaped-charge warhead was smashed against the enemy tank armor before the hypersonic jet could properly form. The wartime HEAT warheads employed simple mechanical impact fuzes that took around 100 microseconds to function. The technological breakthrough that made it possible to use HEAT projectiles from high-velocity guns was the piezoelectric fuze that could initiate the shaped-charge detonation much more quickly.

The US Army began developing such a projectile for the 90mm gun and 120mm gun in February 1950. Besides the new piezoelectric fuze, the new projectile used fins at the rear to reduce spin. It was widely recognized that the existing 90mm APC and HVAP projectiles were ineffective against Soviet tanks such as the IS-3. As a result, in 1951 the US Army authorized the use of the new T108 90mm HEAT round for the new M47 tank. The T108 offered excellent penetration, but it had only a 30 percent probability of hit at a range of 2,000 yards. When British intelligence was able to inspect a T-54A tank in Budapest that had been captured by the Hungarian insurgents during the 1956 revolt, the matter became even more urgent. As a consequence, the baseline threat was no longer the T-34-85, but rather the new T-54A medium tank. The T108 went through numerous iterations through the mid-1950s, with the T108E40 finally being standardized as the M348.

Viewing the T108/M348 as a stopgap, the US Army began developing the T300 HEAT round with an aim to improving the long-range accuracy of the projectile as well as dealing with other issues such as failure to detonate when striking at extreme graze angles. This program began in February 1952 but was not considered mature until the T300E59 arrived in 1958–59, becoming accepted for service use as the M431. This projectile was a radical redesign of the HEAT concept and formed the basis for most NATO HEAT projectiles to the present. A 120mm HEAT projectile was developed for the M103 tank, which had an impressive 380mm (15-inch) penetration capability.



M103A2, US Marine Corps, Guantanamo Bay, 1970. (Artwork by Richard Chasemore © Osprey Publishing)



A remarkable photograph of an APFSDS projectile in flight as the aluminum sabot petals peel away from the long-rod penetrator. The sabot holds the small-diameter penetrator centered in the gun tube during the firing process. (US Army)

When adopted in May 1951, the US Army's M304 HVAP projectile had only marginal capabilities against the T-54A, capable of penetrating the turret at ranges up to 750 meters, but not able to penetrate the glacis plate. The US Army then turned to the British approach of APDS with projectiles, such as the 90mm T137. A more radical approach was a long-rod penetrator. Development of this type started in 1951 but proved difficult since its length meant that the fins were located within the propellant casing. When fired, the fins were subject to deformation by the propellent detonation. As a result, this type of kinetic energy penetrator did not emerge as a mature projectile until the early 1960s, by which time it was known as APFSDS (armor-piercing, fin-stabilized, discarding-sabot).

Another approach, favored by the UK, was the HEP or HESH projectile. This type of warhead was not designed to penetrate the armor. Instead, the high-explosive warhead was allowed to squash against the target armor plate before the delayed detonation. When detonated, it created a shock wave on the armor plate that broke off a scab of armor plate on the inside of the tank armor. Although the US Army developed a HEP round for the 90mm gun, it was not a significant ammunition type in the 1950s. It was used on other weapons, such as recoilless rifles.

The chart here provides comparative data for a wide range of US 90mm ammunition types, and so provides some sense of the relative performance of different types of ammunition in this era.

US Army 90mm tank gun ammunition data

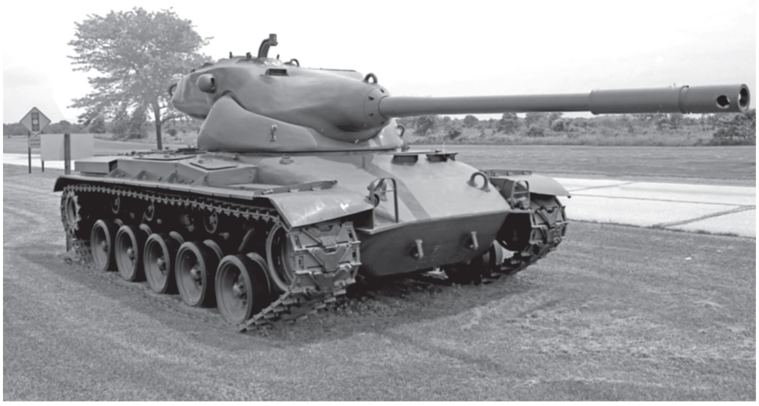
Standard round	M318A1	M348	M431	M304	-	-
Development designation	T33E7	T108E40	T300E59	T30E16	T137	T142E5
Type	APCBC	HEAT	HEAT	HVAP	HVAPDS	HEP
Total weight (kg)	20.4	17.6	14.7	16.8	15.0	15.3
Projectile weight (kg)	10.9	7.3	5.8	7.6	5.4	7.8
Propellant charge (kg)	3.7	3.9	3.9	3.8	3.8	3.6
Velocity (m/s)	930	855	1,220	1,020	1,250	855
Penetration (mm)						
1,000 yds, 0°	157	305	340	256	350	100
1,000 yds, 30°	114	261	290	197	271	100
1,000 yds, 55°	84	226	252	76	101	100
1,000 yds, 60°	71	152	252	64	94	100
2,000 yds, 0°	150	305	340	195	282	100
2,000 yds, 30°	101	261	290	151	226	100
2,000 yds, 55°	71	226	252	58	94	100
2,000 yds, 60°	63	152	252	49	76	100

Comparative performance of medium tank guns, 1950–60

Caliber	**84mm**	**90mm**	**90mm**	**100mm**
Army	UK	US	US	USSR
Gun type	20-pdr	M41	M41	D-10T
Round	Mk III	M318A1	M348	BR-412D
Type	APDS	APCBC	HEAT	APCBC
Penetration @ 30°				
1,000m (mm)	159	104	238	157
2,000m (mm)	141	92	238	132

THE BOBBLE-HEAD TANKS

Aside from traditional tank designs such as the M47 and M48, the US Army conducted a number of experimental tank designs to examine novel technologies. One of the larger programs was started in 1951 to develop oscillating turrets with autoloaders.



The T69 was an experimental medium tank with an oscillating turret. It was armed with the T178 90mm gun fed by an autoloader in the turret bustle. (Author)

The impetus for this configuration was the desire to increase the rate of fire of tank guns, a goal that might be achieved with the use of an autoloader. The problem with the use of an autoloader in a conventional turret was that the autoloader had to continue to adjust to the elevation of the gun, and this proved to be too mechanically complex. In May 1950, the Army funded the development of three different autoloaders for the T43 heavy tank. Trials convinced the Army that autoloaders were practically impossible in a conventional turret.

An oscillating turret solved this problem. In contrast to a conventional tank turret where the gun elevation is made possible by a trunnion within the turret shell, in an oscillating turret, the bulk of the turret including the gun elevates by means of an external trunnion mounted on the turret ring. This permits an autoloader to be fitted in the turret bustle or elsewhere since the turret and autoloader move in unison with the gun.

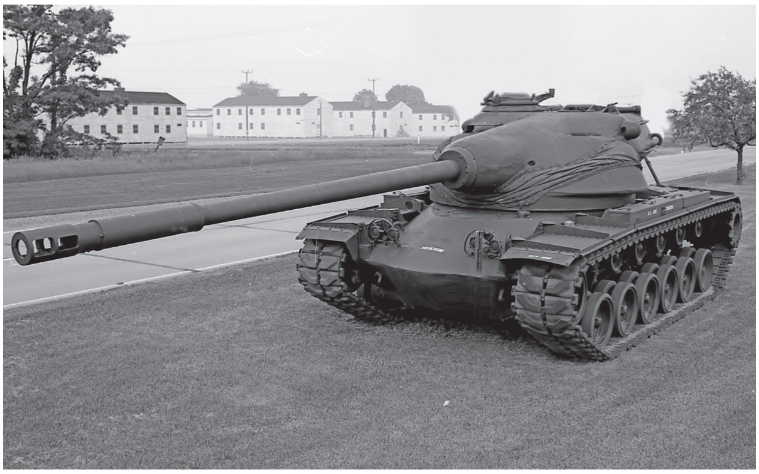
Progress on oscillating turrets was assisted by US trials of two French tanks with oscillating turrets, the AMX-13 with a 75mm gun and the AMX-50 with a 100mm gun. These tanks were sent to Aberdeen Proving Ground for trials since the US was funding the production of several foreign tanks to equip NATO allies under the MDAP program. The AMX-13 was tested in 1951 and approved for MDAP funding. The

AMX-50 was initially tested in 1952 but was not accepted for the MDAP program. However, the Army Field Forces Board found the oscillating turret with autoloader to be worth further examination, and it also promoted the French concept of automatic ejection of the ammunition casing after firing.

Several different tanks using guns of varying caliber were developed under the direction of the Detroit Arsenal. The T69 90mm gun tank was an effort to redeem the T42 medium tank by fitting it with an oscillating turret and autoloader. After examining six different configurations, one from Rheem Manufacturing Co. was selected for construction. One of the existing T42 tanks was used as a test bed for the new turret, and trials began at Aberdeen Proving Ground in May 1955.

The T54E1 105mm gun tank was a derivative of the M48 tank, fitted with a T54E1 105mm gun in an oscillating turret. The turret was developed by the United Shoe Machinery Corporation. The pilot of this tank was delivered in April 1955. A 120mm oscillating turret was being developed at the same time, which was adapted to fit the T48 chassis and designated as the T77 120mm gun tank.

The T57 120mm gun tank was a parallel program based on the T43/M103 chassis. Rheem Manufacturing, which had worked on a previous autoloader for the T43, was given a contract to develop an oscillating turret and autoloader. The specifications for this weapon were impressive, including the capability of firing all of its eight 100-pound projectiles from the autoloader's revolver in only 16 seconds. Rheem was never able to complete a satisfactory design, and one of the two pilots was sent to the Erie Ordnance Depot in the hopes of developing a rigid, non-recoiling gun mount that would be easier to employ with the autoloader. There had been some interest in developing a 155mm tank gun that would be capable of firing HEAT or HESH ammunition. As a result, a further oscillating turret design was initiated on the T43E1, the T58 155mm gun tank. Development of the turret and autoloader was undertaken by the United Shoe Machinery Corp.



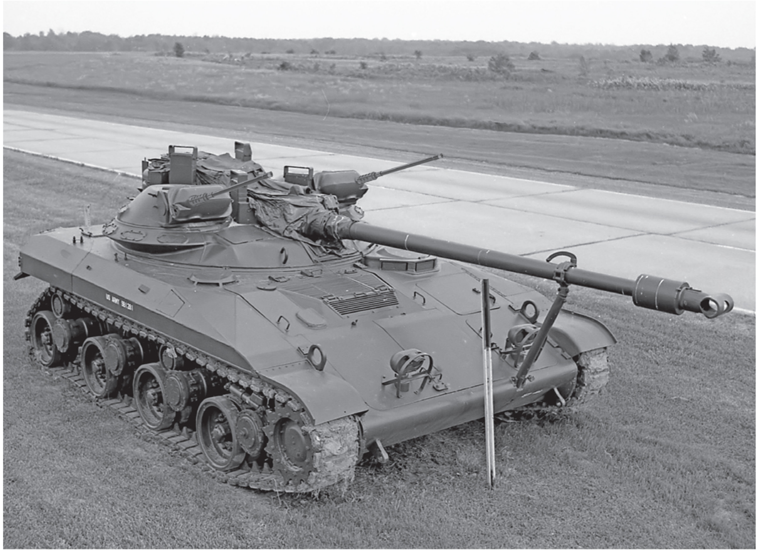
The T54E1 was a 1951 project for a tank with oscillating turret and a 105mm gun with a nine-round autoloader. (Author)

Several of the oscillating turrets were subjected to ballistic trials. These disclosed that oscillating turrets offered both positive and negative features compared with conventional turrets. On the one hand, the lack of a gun mantlet provided an especially durable front armor array. However, the yoke and trunnion assembly provided very mixed protective features with some distinctive weaknesses.

By 1957, the Army had lost interest in the oscillating turret concept and instead was turning its attention to a new tank design, the T95. Aside from the ballistic problems, the autoloaders had proven to be a mechanical nightmare, and the space consumed by the autoloaders significantly reduced the stowed ammunition onboard the tank. For example, the T69 90mm gun tank stowed only 40 rounds of ammunition compared with 60 rounds in the M48 90mm gun tank. By the late 1950s, the Army was beginning to pay more attention to nuclear and chemical weapons on the future battlefield. An oscillating turret was far more difficult to seal from contaminants than a conventional turret. As a result, these programs were canceled in early 1957 and the test assets handed over to other programs for possible integration into future efforts.

THE T92 76MM GUN TANK

Due to the lingering technical problems with the M41 76mm gun tank in the early 1950s, the US Army began to consider whether a smaller and lighter tank might be more suitable for the reconnaissance role. The T71 tank proposed by the Detroit Arsenal weighed only 18 tons. It was armed with a 76mm gun in an oscillating turret with 18 rounds in its autoloader. Two alternative designs were considered: a Cadillac design with a conventional turret and an Aircraft Armaments Incorporated (AAI) design that used an unconventional rear-mounted, low-profile turret. The requirements were discussed in 1953 at the Detroit Arsenal, with the oscillating turret T71 abandoned before completion of a pilot tank in favor of the Cadillac or AAI designs. The new program was formally initiated on September 1, 1953, with the Cadillac design retaining the T71 designation and the AAI design being designated as the T92. The program was narrowed down to AAI's T92 tank in January 1956 due to the better progress on its design as well as a general shortage of development funds. The intention was to begin production in 1962.



The T92 76mm gun tank was one of a string of US Army attempts to field a light tank suitable for rapid deployment to regional conflicts. It had a revolutionary configuration, with a rear-mounted turret and machine-gun cupolas for both turret crewmen. (Author)

The T92 tank had a front-mounted AOI-628-1 340hp engine. The tank used an innovative torsilastic suspension with rubber band track.

The turret was a low-profile cleft design with a T185E1 76mm gun with a hydrospring recoil system. Both the gunner and commander were provided with traversable .50-cal machine-gun cupolas. The T92 weighed only 16 tons unloaded and 18.6 tons loaded due to its thin armor. It was only 1.5 inches (38mm) at its thickest point on the turret front. The two pilots were delivered in November 1956 and February 1957. The test program revealed the usual number of modest technical problems with the design, though it proved to be otherwise sound.

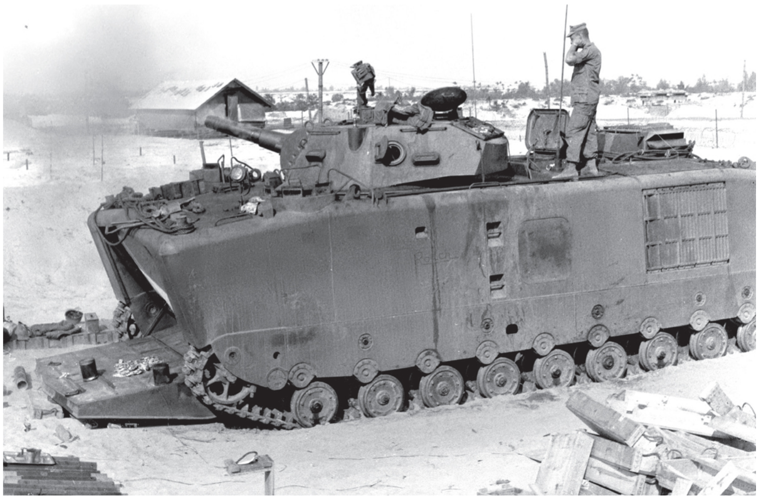
In early 1957, a Congressional committee asked why the Army hadn't developed an amphibious reconnaissance tank comparable to the Soviet PT-76. It was quickly determined that it was not feasible to adapt the T92 design to an amphibious configuration without creating an entirely new design. As a result, in 1958 the T92 program was shelved in favor of a future light tank that eventually emerged as the M551 Sheridan. As will be detailed later, AAI continued to work on unconventional light tanks patterned on the T92 through the 1980s, though none would enter serial production.

AMPHIBIOUS TANKS

At the time of the Korean War, the Marine Corps was suffering from a shortage of amtracs and amtanks to support its intended force-goal of two amtrac battalions and two reduced-strength armored amphibian battalions. Restarting production of the wartime types made little sense, and in December 1950, the Navy's Bureau of Ships issued development contracts to FMC Corporation. and the Ingersoll Division of Borg-Warner to develop a new family of amphibious vehicles. Although the primary variant of this family was an amphibious armored personnel carrier, the Marines wanted a fire support vehicle as well, armed with a 105mm M49 howitzer in a T172 mount. Pilot models of the Ingersoll LVTH-X1 were completed in August 1951, and FMC followed suit in 1952 with its LVTH-X4. The Ingersoll design was entirely new, while the FMC design was smaller since it was based on its M59 armored personnel carrier. The Navy decided to proceed with the manufacture of the Ingersoll vehicle as the LVTP-5 in its personnel version and LVTH-

6 in its fire support version. The FMC design was accepted as the LVTP-6 in 1956 but never entered serial production.

The LVTH-6 was substantially larger than the World War II amtanks, some 29 feet in length with an empty weight of 37 tons. It was powered by a Continental V-12 810hp engine. It had a road speed of 30mph and a water speed of 6.8mph. A major advantage of the new amtrac family was that it was entirely enclosed and so could handle 15-foot surf. The LVTH-6 could carry up to 151 rounds of 105mm ammunition on land but was limited to 100 rounds when in the water.

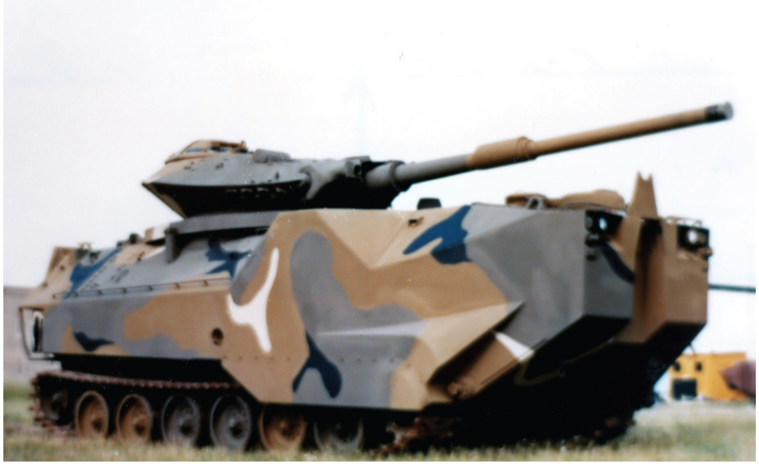


The LVTH-6A1 was the fire-support version of the LVTP-5 amtrac series but fitted with a turret-mounted 105mm howitzer. It is seen here with the Marine 1st Armored Amphibian Company supporting the 1st Marine Division in Vietnam on January 31, 1968.

Serial production of the LVTH-6 began in 1952, with Ingersoll manufacturing 175 and Pacific Car and Foundry another 35 for a combined total of 210 vehicles. Additional LVTH-6s were manufactured for the Republic of China (Taiwan). The LVTH-6 used the same transmission as the M47 and M48 tanks, but had a different powertrain that required a drop-gear to couple the final drives and transmission. This proved to be the source of significant problems. Fixes for this problem as well as other improvements such as a box snorkel and top-deck ventilators were incorporated in a modification program, resulting in the LVTH-6A1. In total, 329 LVTH-6s were in Marine service by the early 1960s.

The combat role of the LVTH-6 was essentially similar to the wartime amtanks, providing fire support during the initial landing. The LVTH-6 was not well enough armored to conduct direct-fire missions once on land against any opponent armed with even modest anti-tank weapons. As a result, once on land the LVTH-6 was generally subordinated to the local artillery force and used in an indirect fire mode like a self-propelled howitzer. The howitzer amtrac gradually fell out of favor and most were retired by the mid-1960s when the Marine units began to deploy to Vietnam. One platoon was deployed to Vietnam in 1965, and the 1st Armored Amphibian Company was activated in June 1966 for service in Vietnam. The LVTH-6 was formally retired in 1970.

When the Marine Corps developed a new family of amtracs starting in 1962, a mobile gun version was not included. The LVTP-7 began to arrive in Marine service in 1972. The Bureau of Ships did experimentally fit an M551 Sheridan turret armed with a 105mm tank gun to an LVTP-7 chassis, but this proceeded no further than trials.

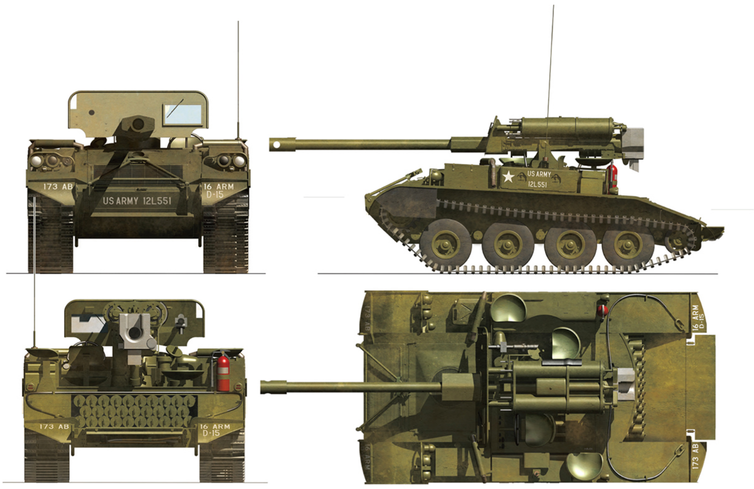


The last of the amtanks was the LVTEX-3, a prototype using the turret of a Sheridan tank fitted with a low-recoil 105mm gun.

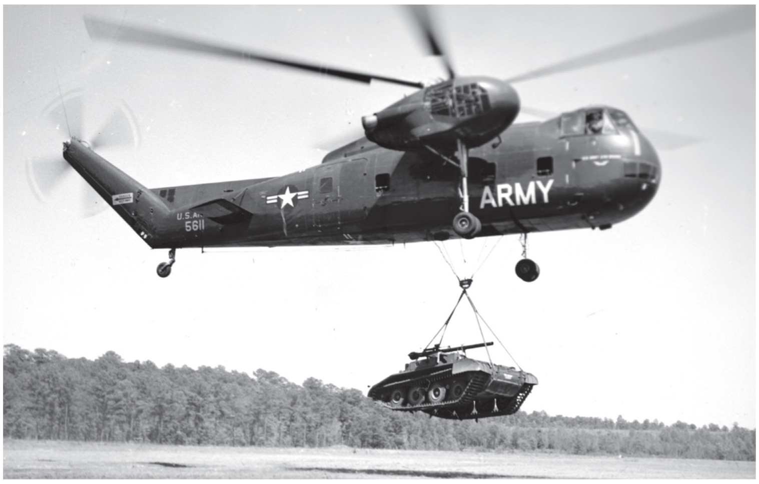
COLD WAR AIRBORNE TANK DESTROYERS

There was some recognition that to field a vehicle light enough to be easily air-transported, some aspect of a tank's principal characteristics – armor, firepower, mobility – would have to be compromised. One possibility was to decrease or eliminate the armor protection and design a mobile gun to provide the airborne divisions with mobile firepower. In the late 1940s, the airborne divisions were equipped with the widely despised 90mm M26 towed anti-tank gun, which was simply too clumsy to be a practical airborne weapon.

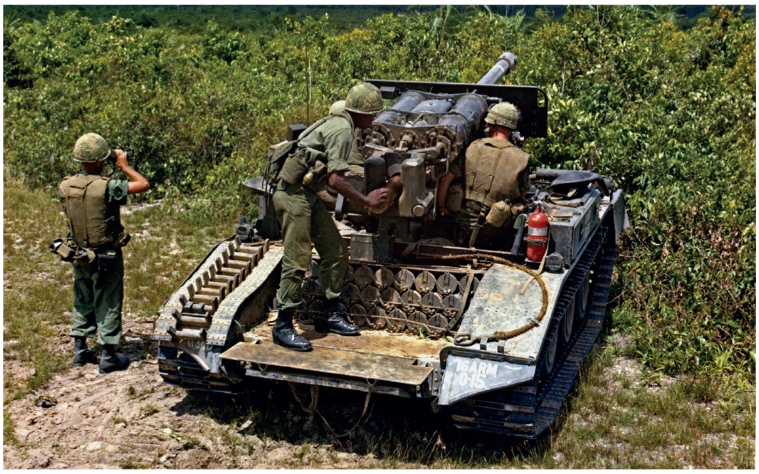
In April 1949, the Army began a program to field a self-propelled 90mm gun as a more portable expedient to the inadequate towed antitank gun or some form of light tank. Development was undertaken by the Cadillac Motor Car Division of General Motors, and the first T101 pilots were completed in 1953 and tested by the Armor Board at Fort Knox in 1955. It was type classified in 1958 as the M56 90mm self-propelled gun, though it was better known by its nickname "the Scorpion" or by its acronym SPAT (self-propelled anti-tank). It was built in very modest numbers, with 160 manufactured from December 1957 to June 1958. Some even lighter configurations were considered, including the use of a single 106mm recoilless rifle instead of the 90mm gun. However, none of these was manufactured aside from prototypes.



M56 90mm self-propelled anti-tank (SPAT) gun. (Artwork by Henry Morshead © Osprey Publishing)



The M56 Scorpion was intended to be light enough to permit transport by helicopter. This is a demonstration at Fort Benning on August 14, 1958, using an M-37 Mojave helicopter to deliver an experimental version of the M56 fitted with a 106mm recoilless rifle instead of the usual 90mm gun.



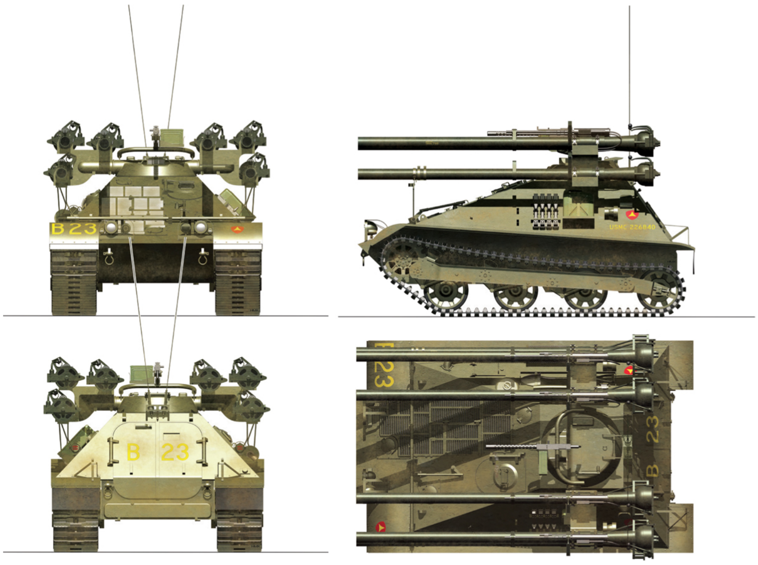
An M56 Scorpion of Co. D, 16th Armor, of the 173rd Airborne Brigade near Bien Hoa, Vietnam in June 1965. Although well armed for such a light vehicle, the SPAT offered the crew little armored protection.

Besides being issued to airborne units, it was also used in the anti-tank companies of some infantry divisions in the late 1950s and early 1960s. The Scorpion was so light it could be airlifted by some of the heavy-lift helicopters of the day and was also suitable for parachute dropping. Its main fault aside from the obvious lack of armor was the substantial recoil of its gun, which would lift the front into the air when firing. The Scorpion was adequate in a defensive anti-tank role, but its lack of armor made it unsuitable for providing offensive punch. With the advent of effective anti-tank missiles, the defensive role was better undertaken by missiles mounted on the M151 jeep. The Scorpion saw service in Vietnam with Co. D, 16th Armor (Airborne Anti-Tank) of the 173rd Airborne Brigade, with these units having 17 vehicles each organized into three platoons. Use in Vietnam revealed its obvious shortcomings, and it was quickly retired. A total of 87 were provided to Morocco and five to Spain under the military aid program.

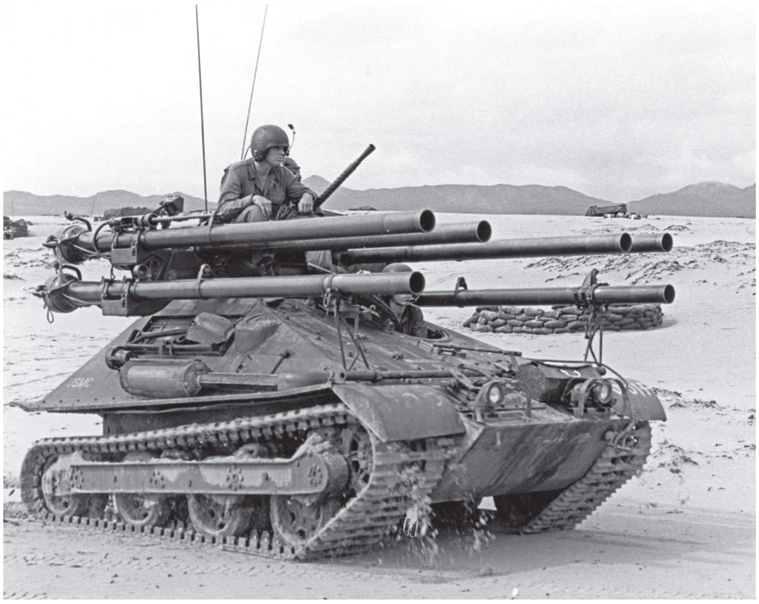
Another approach to this requirement was the use of lightweight recoilless rifles. In the late 1940s, an unrecorded US Army officer came up with the idea of arming the numerous agricultural tractors in Germany with recoilless rifles as expedient tank destroyers to serve as a counterweight to the "Red Horde" of Soviet tanks. The idea was to develop a modular kit that could be dropped on to a tractor, providing it with basic armor and hefty firepower. This idea proved more difficult to execute than expected, but the core idea remained that recoilless rifles could be mated to a simple armored tracked vehicle to create a cheap tank destroyer that could be built in large numbers. The requirement was outlined in an Army equipment development guide released in December 1950 that was heavily influenced by the recent tank panic in Korea. The new vehicle was originally called the Infantry Assault Vehicle (IAV), as the plan was to keep the design as simple as possible to allow its use by infantry troops rather than dedicated armored force personnel.

The IAV project was given the odd name of "Ontos," Greek for "the Thing," which did not follow any standard Army nomenclature before or since; the reason for this weird name remains obscure. An initial design was developed by the Detroit Arsenal, and an industry team was established in 1950 including Ford, General Motors, Allis-Chalmers, and the Detroit Arsenal. After a conference at Fort Monroe in March 1951, the original plan was to mount four 106mm recoilless rifles on the vehicle. This was increased to six rifles in June 1951, and a wooden mockup was prepared at Detroit Arsenal in time for a final conference on July 20, 1951, when the final plans were formalized. Allis-Chalmers Manufacturing Company, the well-known construction equipment company, was selected with a contract on October 26, 1951. The program examined six different configurations of the common IAV family, including the T55 six-man troop carrier, the T56 ten-man troop carrier, the T164 tank destroyer with four rifles, the T165 with six rifles, the T166 with one rifle, and the T167 with eight rifles.

After a number of pilot vehicles were built and tested, the Ontos concept was narrowed down to a six-rifle tank destroyer, with the infantry transporter configurations and other versions gradually abandoned. On February 24, 1953, another contract was awarded to Allis-Chalmers, with plans to increase the pilot production of the six-rifle version to 24 vehicles, with the improved version being designated as T165E2 in January 1955. The new 106mm T170E1 recoilless rifle was type classified as the M40 in July 1953 and accepted as the standard armament for the Ontos. The US Army eventually developed cold feet over the whole concept, shifting attention to guided anti-tank missiles such as the Dart for the dedicated anti-tank role, and the more conventionally armed M56 90mm SPAT Scorpion for light units.



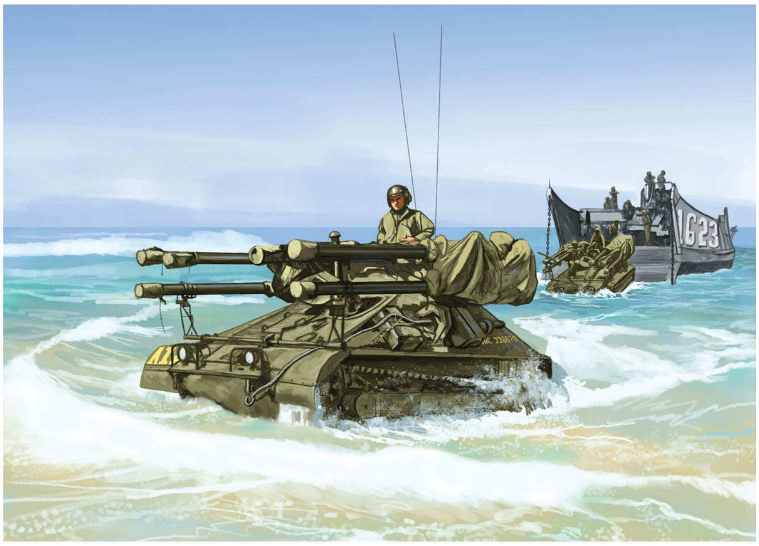
M50A1 Ontos. (Artwork by Henry Morshead © Osprey Publishing)



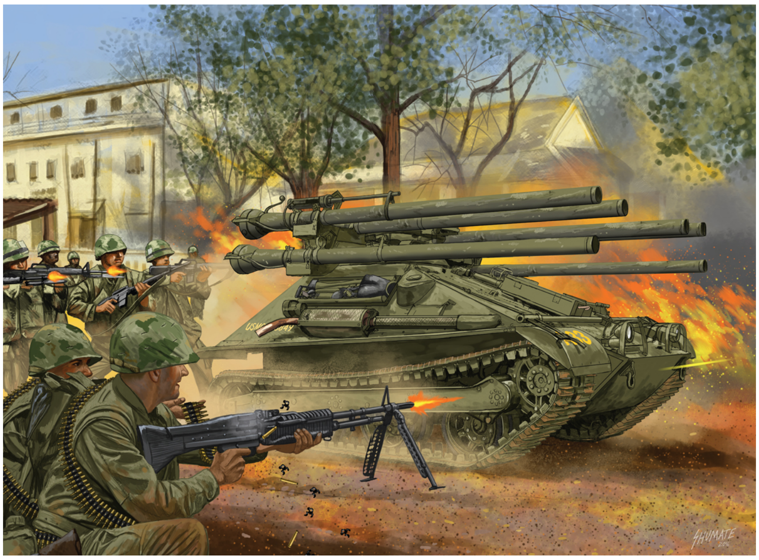
An M50 Ontos of Co. A, 1st Anti-Tank Battalion, 1st Marine Division, during Operation *Mobile*, a search-and-destroy mission on the sea coast in Quang Ngai Province on May 28, 1966.

In spite of Army indifference, the US Marine Corps had developed an interest in the Ontos, since such a small vehicle would be easier to deploy in amphibious operations than more conventional anti-tank guns or tanks. The Marines did not keep their regimental tank platoons active in peacetime due to budget restrictions. As a result, the idea of a cheap, simple vehicle that could be operated by ordinary infantry was very attractive in the wake of the Korean experience. The lessons from that conflict were that better anti-tank capability was needed and that existing towed anti-tank guns were impractical and ineffective. Based on Marine interest, the T165E2 pilot was standardized as the "Rifle, Multiple, 106mm, Self-Propelled, M50" on March 24, 1955, and a production contract for 297 vehicles was awarded to Allis-Chalmers on August 12, 1955. The actual production version differed considerably in detail from the T165E2 pilots. Production of the Ontos was completed on November 30, 1957. The new vehicles were issued to the divisional anti-tank battalions in each Marine division with 45 vehicles per battalion; there were three such battalions in service in the late 1950s and early 1960s.

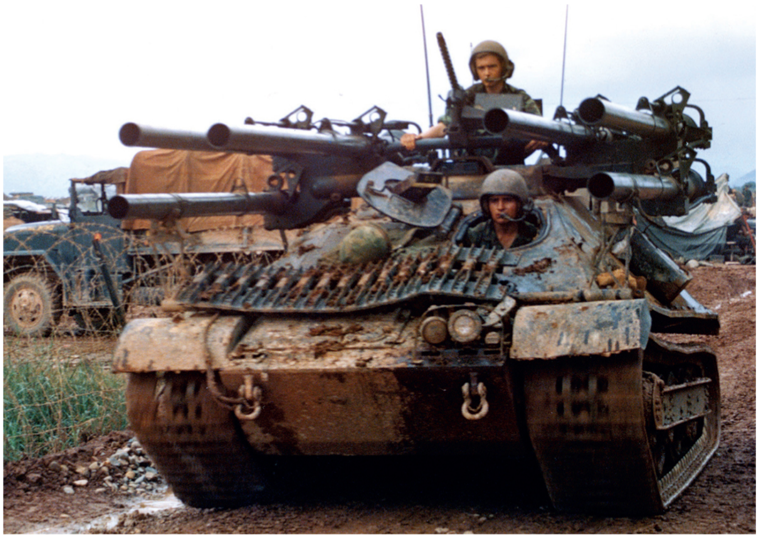
The M50 Ontos had a crew of three consisting of a commander/gunner, loader, and driver. It weighed only 9.1 tons combat loaded and had a maximum road speed of 30mph. The six M40A1C 106mm recoilless rifles were clustered in two groups of three on either side of a cupola that could traverse 40 degrees



M50A1 Ontos wading ashore from assault craft. (Artwork by Johnny Shumate © Osprey Publishing)



M50A1 Ontos during the Battle of Hue, 1968. (Artwork by Johnny Shumate © Osprey Publishing)



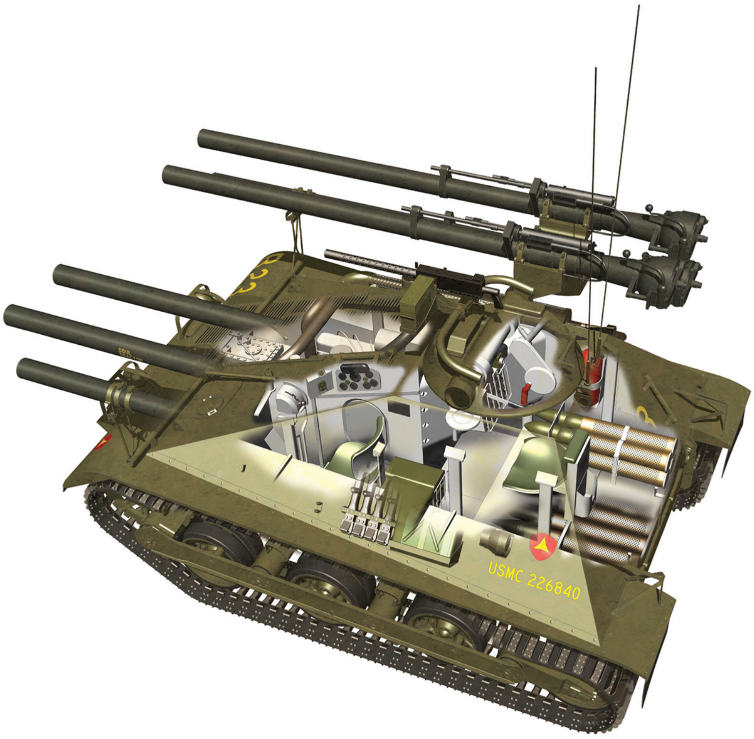
An M50 Ontos of the 3rd Anti-Tank Battalion, 3rd Marine Division, moving out of base camp near Cam Lo in Quang Tri Province on November 21, 1968.

to either side with an elevation of -10 to +20 degrees. Two of the recoilless rifles were fitted with an accompanying spotting rifle that could be fired to determine range and any necessary super-elevation needed before firing the main weapon. The firing controls permitted single rifle fire or simultaneous firing of two rifles. A total of 18 rounds of ammunition were carried: six in the rifles, four inside the hull, and eight in a pannier under the crew compartment floor that was accessible through a rear hatch outside the vehicle.

The Ontos saw its first major overseas deployment during the 1958 Lebanon crisis when ten were landed as part of the Fleet Marine Force. Besides its use with the Marine divisions, the Ontos was regularly deployed with Marine garrisons – for example, an Ontos platoon at the US Naval Base Guantanamo at the time of the Cuban Missile Crisis in 1962. The Ontos was again used to support USMC Battalion Landing Teams during the crisis in the Dominican Republic in April 1965.

After initial use of the M50 Ontos, the Marine Corps decided that a more powerful engine was needed than the GM Model 302 145hp engine used in the initial production series. In May 1960, the plans were approved to incorporate the Chrysler Model 75-M2 engine, later designated as the HT-361, which offered 180hp. The improved version was designated as the M50A1 on September 27, 1962. On June 25, 1963, Allis-Chalmers was awarded a contract to convert 294 of the original 297 vehicles to the M50A1 configuration. This version can be distinguished from the original production batch by the added vent grills on the lower hull front, though many other small changes were also introduced.

The Ontos saw its only major combat use during the Vietnam War. Besides its nickname of Ontos or “the Thing with a Sting,” the M50A1 was popularly called “the Pig” by its crews in Vietnam. The first Ontos arrived in Vietnam in March 1965 with the 9th Marine Expeditionary Brigade. Eventually, both the 1st and 3rd Anti-Tank Battalions were deployed to Vietnam. The Ontos proved considerably less useful than the better-armored M48 Patton tanks. It was sometimes used for convoy escort missions, but its light armor made it extremely vulnerable to mines. As a result, it was most often used for the defense of static points and for perimeter patrol. The Ontos also suffered from some specific technical issues, such as a tendency of the electrical system to accidentally trigger the firing of the rifles. The Ontos was perhaps best known for its use in the fighting in the old imperial city of Hue during the Tet Offensive in January 1968, where its small size and heavy firepower proved very effective in urban fighting. Two Ontos platoons were also assigned to the 77-day siege of Khe Sahn. The Marines deactivated the Ontos after the spring of 1969, but some Ontos were turned over to local US Army units in Vietnam, including Co. D, 16th Armor, with the 173rd Airborne Brigade, who wanted them since they could be flown into combat zones using CH-53 “Flying Crane” helicopters. In the wake of the Vietnam War, the Ontos was retired, although there were a few schemes to modernize it with anti-tank missiles.

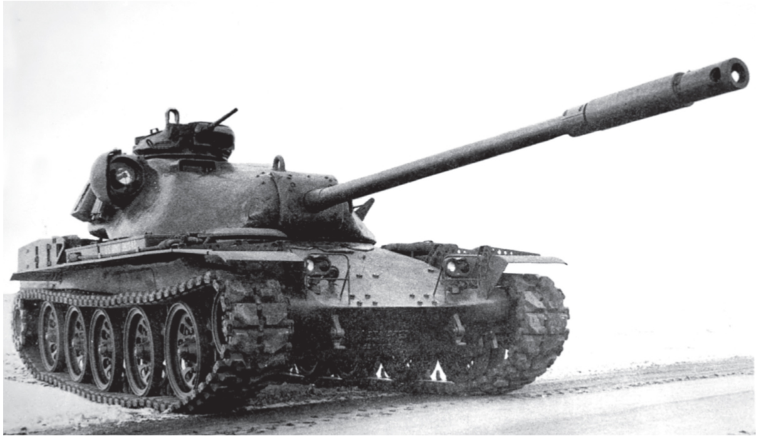


M50A1 Ontos. (Artwork by Henry Morshead © Osprey Publishing)

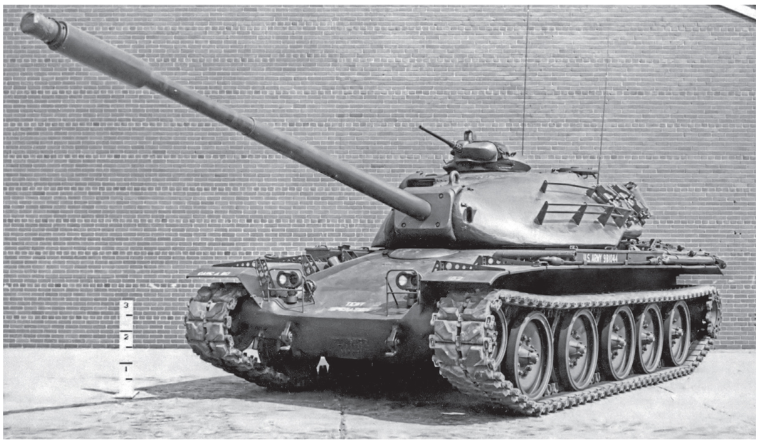
REVOLUTION OR EVOLUTION: THE T95 TANK

The US Army held periodic brainstorming conferences in the early 1950s called "Question Mark" that examined futuristic concepts for new weapons. Based on some of the proposals suggested at the Question Mark III conference, in September 1954 the Joint Chiefs of Staff approved the design of a family of new tanks. Among these were the TL-1 90mm tank, the TL-4 105mm tank, and the TS-31 120mm tank. These eventually emerged as the T95, developed by the Detroit Arsenal, the T96 developed by Ford, and the T110 120mm tank. These were expected to use rigidly mounted guns that lacked the traditional recoil system in an attempt to save space in the turrets.

The program was substantially reorganized in November 1956, with the T110 entirely eliminated and the T96 turret designs folded into the surviving T95 program. Nine different T95 pilots were planned, four with the T208 smooth-bore 90mm gun, four with the 105mm smooth-bore T210 gun in the T96 turret, and one using a 90mm T208 gun but incorporating a traditional recoil system. Two related technologies were under development for these tanks: new APFSDS ammunition, and an optical tracking acquisition and ranging (OPTAR) rangefinder. The intention was to raise the muzzle velocity of the guns from the available performance of 3,600 feet per second to 5,000 feet per second. In early 1957, the program was expanded to examine other weapons, including a British 120mm gun, the Dart anti-tank missile, and the 105mm boosted rocket launcher.



The first pilot of the T95 90mm tank was fitted with the early lightweight road wheels. A prominent feature of this version was the OPTAR optical rangefinder on the right side of the turret.

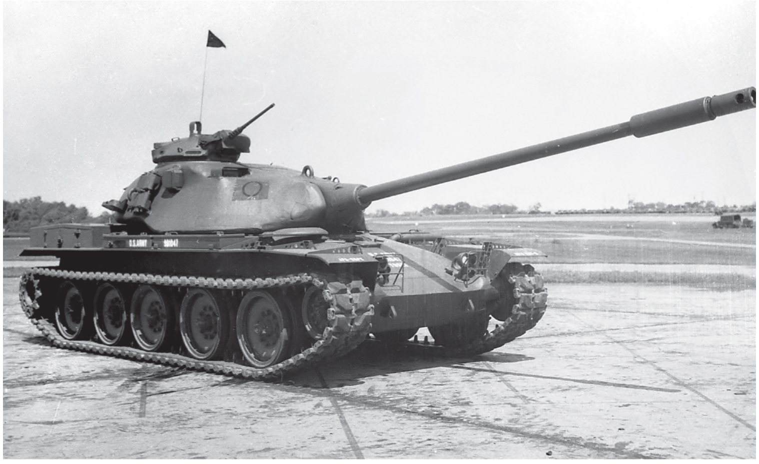


The second pilot of the T95 tank was armed with the 90mm T208E13 gun.

The T95 tanks shared a common chassis with an integrated powerpack consisting of a transversely mounted Continental AOI-

1195-5 engine and an Allison XTG-410-1 transmission offering 560hp. The first T95 pilot used special lightweight road wheels, while the T95E1 second pilot used more conventional wheels. Two of the pilots, the T95E2 and T95E3, were used primarily for automotive trials, and the T95E2 was fitted with the turret from an M48A2 tank to conduct automotive trials. The T95E3 pilot was the first fitted with the enlarged turret for the T140E3 105mm gun, although turrets were often swapped during the trial process. Automotive trials found that the T95 was inferior to the existing M48A2 tank in cross-country mobility. As a result, other powerplants were considered.

In parallel with the T95 program, the Detroit Arsenal had been examining the new British 105mm gun as a potential replacement for the 90mm gun used in the M48 series. This was mounted in a modified M48A2 turret and tested on the T95E7 as an alternative to the experimental rigidly mounted guns. In late 1958, the program was reorganized again with eight gun/turret combinations accepted for further development. In general, the rigidly mounted smooth-bore guns proved to be a dead end. The long tubes were prone to distortion that degraded their accuracy. The rigid mounting transmitted high G-forces into the turret, adversely affecting subsystems, especially the complicated fire controls.



The T95E1 used the T208E1 90mm gun with a concentric hydrospring recoil mount that permitted a narrower turret front.

There was growing disenchantment with the T95 program due to the automotive problems with the chassis and the confusing and overlapping armament solutions. On January 28, 1959, the Chief of Ordnance directed the termination of work on the new smooth-bore 90mm and 105mm guns, and on July 7, 1960, the T95 program was scrapped, having spent about $18 million on its development. Some of the chassis remained in use for testing other technologies such as variable height suspension.

Although the T95 program had demonstrated a number of interesting new technologies, many of them were at the bleeding edge of technology and not yet mature enough for mass production. A later assessment of the program noted the valuable technological spin-offs from the program, including optical ranging technology, obturation to high-pressure gun breeches, high-velocity projectile development, infrared shielding of exhaust gases via the use of coolant air, and improved gun stabilization technologies.

CHAPTER FOUR

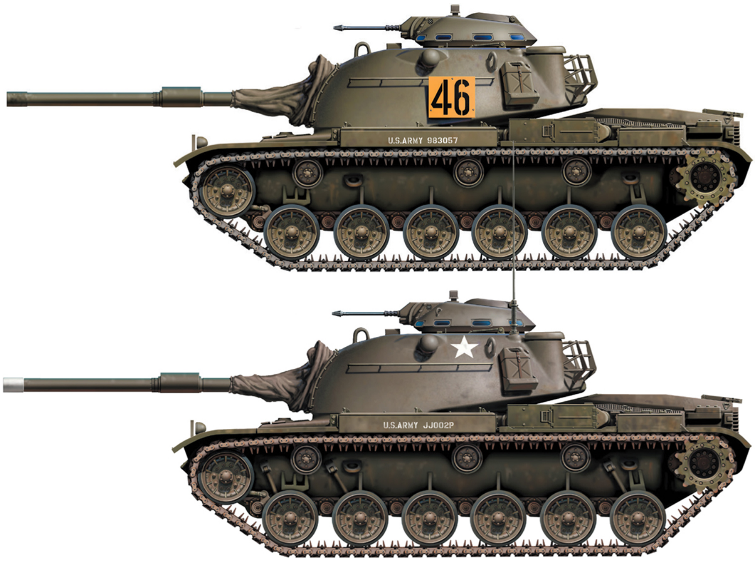
COLD WAR TANKS: THE 1960S GENERATION

The 1960s were an echo of the previous decade, with the Army embarking on a revolutionary new tank, the MBT-70. Like the overly ambitious T95, the MBT-70 was a failure. Once again, the Army was forced to rely on yet another evolutionary variant of the M26/M46/M47/M48 family, the M60. There were a number of troubled light tank programs during this decade, though the term "light tank" fell out of favor.

M60 105MM GUN TANK

One of the primary tactical shortcomings of the M48 tank series was the limited range due to the poor fuel economy of the engine. In November 1956, OTAC (Ordnance Tank and Automotive Command) initiated the testing of a new Continental AVDS-1790-P diesel engine in the M48A2 tank as the M48A2E1. The new engine increased the road range from 160 miles to 310 miles.

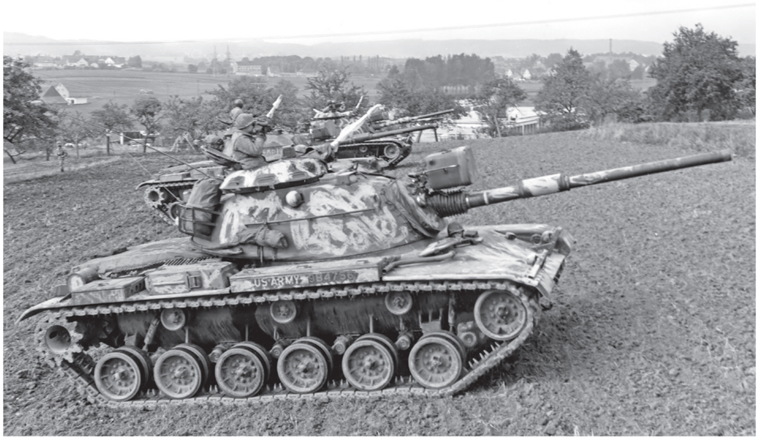
During the Hungarian Uprising in 1956, Hungarian insurgents captured a Soviet T-54A tank and drove it into the grounds of the British embassy in Budapest. British officials hastily measured its armor thickness. Curiously enough, their report slightly exaggerated the T-54's armor as 120mm at 60 degrees when it was in fact 100mm at 54 degrees. The existing NATO tank guns including the US 90mm gun were not effective enough to deal with this level of protection, and there was a race to field more powerful tank guns. While the US Army was examining radical solutions such as the smooth-bore 105mm gun with APFSDS projectiles, Britain took a more cautious approach and developed its rifled L7A1 105mm gun. The US Army tested several gun candidates in October 1958 and selected the British L7A1 gun tube mated to the US T254E2 breech, resulting in the 105mm M68 gun.



M60 105mm tanks. (Artwork by Jim Laurier © Osprey Publishing)

In late 1958, Maj. Gen. Robert J. Wood, the deputy chief of research and development on the Army staff, remarked in a secret forum: "The XM60 tank [is] an interim vehicle – we had to come up with something because the Bureau of the Budget, in its wisdom, decided we wouldn't buy any more M48s." The combination of the AVDS-1790 diesel engine and the M68 105mm gun was designated as the Tank, Combat, Full-Tracked, 105mm Gun XM60, later standardized as the M60 on April 2, 1959. Expectations about the new tank were lukewarm. Lt. Gen.James H. Polk, commander of the US Army in Europe during the late 1960s, later commented about the M60 that "the reworked tank will not be the best tank on the European battlefield by any stretch of the imagination."

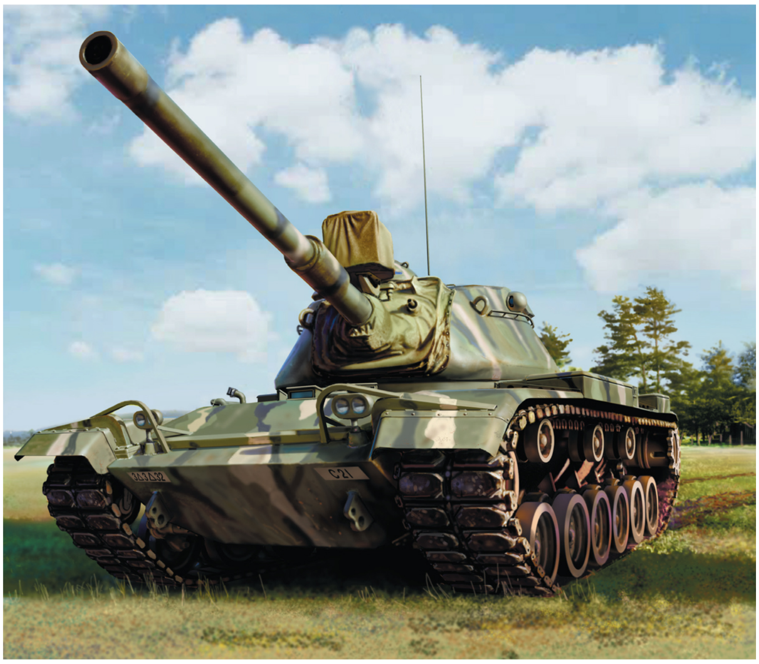
The original M60 tank used a dome-shaped turret very similar to the M48 series except for the substitution of a larger M19 cupola for the old M1 cupola. The M60 also swapped a coincidence rangefinder for the previous stereoscopic rangefinder. The M60 used a new rolled-steel glacis plate instead of the cast front hull of the M48 series. The US Army tested several composite armor packages, including aluminum and silica inserts sandwiched between steel. These armors were found to have better protective performance when subjected to shaped-charge warheads at oblique angles. However, the new armor packages were abandoned in favor of conventional steel armor, since it was felt that the ballistic advantages were outweighed by higher costs, problems repairing damaged armor, and other factors. It's worth noting that the Soviet army was experimenting with composite armor at the same time and adapted a laminate armor consisting of alternating layers of steel and fiberglass for the glacis plate of the new T-64 tank later in the decade.



The baseline M60 tank, sometimes dubbed the M60A0, used a hemispherical turret similar but not identical to that of the M48 Patton. These tanks have been daubed with mud for improvised camouflage during the October 1973 Reforger V exercises near Walkmühle, Germany.

An M60 tank named "By Odin" of Co. B, 2/33rd Armor, 3rd Armored Division, serving as part of the aggressor forces during Operation *Big Lift* in Germany on November 1, 1963.

The initial production contract for the M60 tank was awarded to Chrysler's Delaware defense plant in June 1959, and four pilots were delivered for testing in the autumn of 1959. Serial production began in 1960, initially at the Delaware plant, and subsequently at the Detroit Tank Plant. A total of 2,205 M60 tanks were manufactured through 1963.



M60A1, 3/33rd Armor, 3rd Armored Division. (Artwork by Jim Laurier © Osprey Publishing)

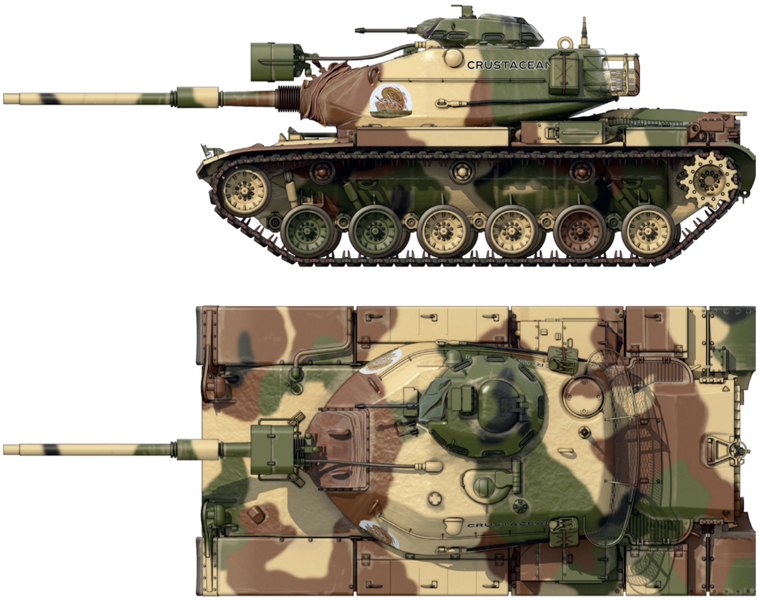
There was some concern that the baseline M60 turret was not adequately protected against Soviet tank guns. In June 1961, a program was authorized to develop a better-designed turret influenced by earlier work on the T95E7 tank. Three M60E1 pilots were built, starting in May 1961 with testing beginning at Aberdeen Proving Ground in June 1961. Although the turret was the primary change, many automotive changes were incorporated into the M60E1, including the switch from the driver's steering wheel to a T-bar steering yoke. The new tank was standardized as the M60A1 on October 22, 1961, and production shifted from the M60 to the M60A1 in 1962, with initial deliveries in October 1962. Besides the US Army, the US Marine Corps procured 444 M60A1, funded under the FY76–FY80 budgets.

The M60 became the US Army's new tank for the next two decades by default. The failure of revolutionary designs such as the T95 and the later MBT-70 left the M60 in production far longer than anyone would have predicted in 1960. If not for the Bureau of the Budget's disdain for the old M48, the M60 might have kept the old M48 designator.

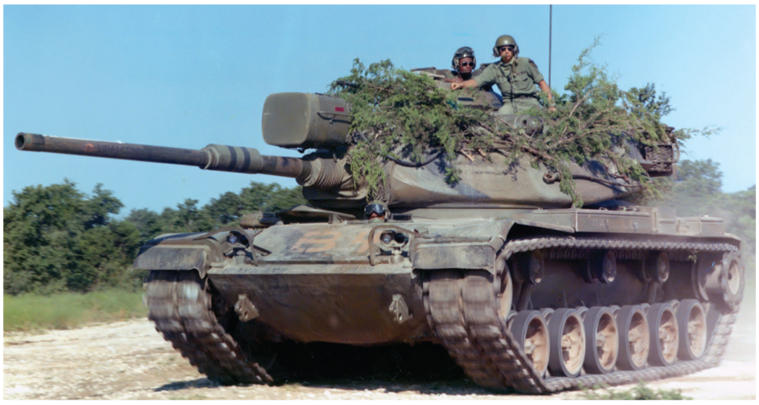
M60A1 IMPROVEMENTS

Due to its unexpected longevity, there was a continual string of improvements to the M60A1 tank during the 1960s and early 1970s. These programs were usually a parallel effort to introduce the new features into new production tanks while at the same time initiating an upgrade effort at Army depots to modernize existing M60A1 tanks during periodic maintenance.

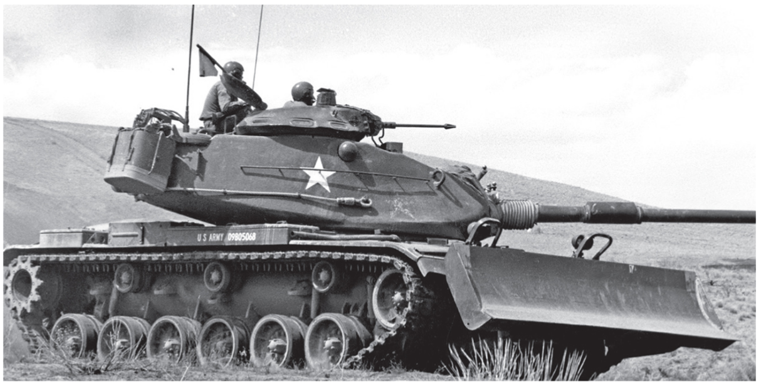
The first improvement was the addition of a top-loading air filter in 1971. The original side-loading air cleaner was very unreliable because its base plate was easily bent when struck with a thrown track. As a result, the filter element no longer sealed properly, and the engine became fouled by ingesting dust that passed through the damaged filter. A new Top-Loading Air Cleaner (TLAC) was adopted to prevent premature engine failures. The original aluminum TLAC was subsequently redesigned using armored steel to reduce its vulnerability to small-arms fire. This was introduced in the late 1970s during depot overhaul or in the field as older air cleaners became unserviceable. The adoption of the TLAC did not result in a designation change to the M60A1, and the program was completed in 1985.



M60A1, 4/3rd Armor, Germany, 1973. (Artwork by Felipe Rodríguez © Osprey Publishing)



An M60A1 with the new T-142 track of Co. B, 5/1st Cavalry, during training at Fort Hood in August 1975. It is painted in the new MERDC camouflage and is fitted with the AN/VSS-1 searchlight.



An M60A1 fitted with a dozer blade taking part in spring gunnery training at the Yakima Firing Center in Washington state on April 29, 1977. Its AN/VSS-1 infrared searchlight is carried on the rear corner of the right turret side.

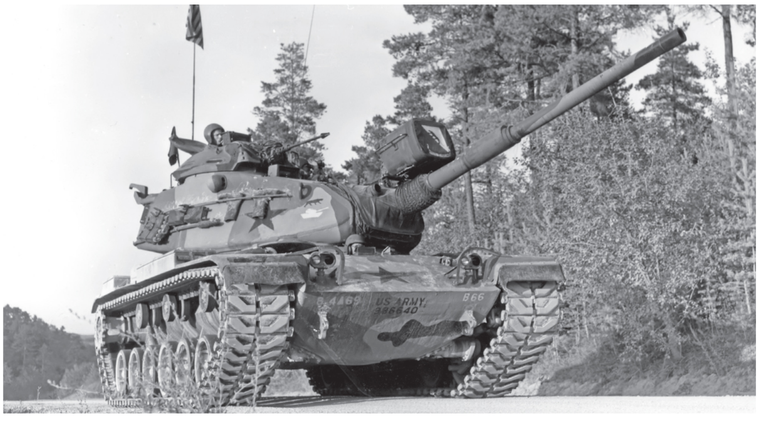
A more significant improvement was the Add-On Stabilization (AOS) system in 1972, resulting in the M60A1 (AOS). The AOS system provided stabilization for both gun elevation and turret traverse. It gave the gunner the ability to aim and track a target while the tank was moving. It also assisted the gunner in surveillance of the battlefield terrain while the tank was moving. Tank crews generally felt that it was most effective at speeds of around 5mph, with performance decreasing at higher speeds or in rougher terrain. The AOS upgrade was completed in 1980.

Beginning in 1974, the M60A1 was fitted with the improved T142 track, superseding the earlier T97E2 chevron track. The T142 used a pair of replaceable rubber pads on the face of each link so that in the event of excessive wear, the pads alone could be replaced instead of the entire track link.

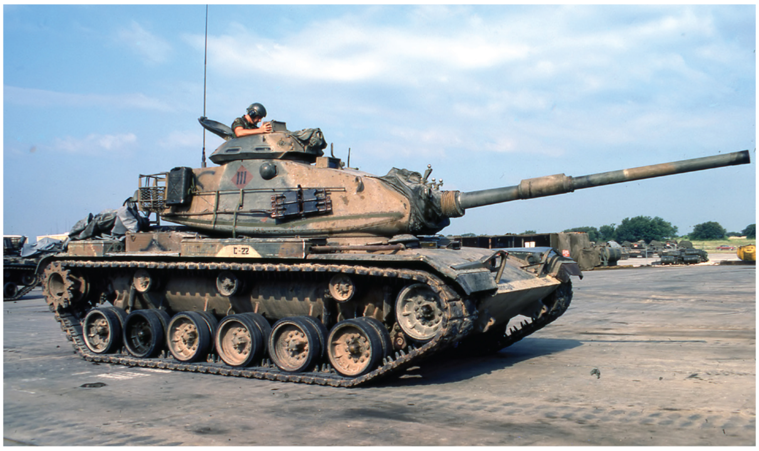
The next major phase of improvements starting in 1975 was the addition of a "Reliability Improvement of Selected Equipment" (RISE) engine, the AVDS 1790-2D with an improved electrical harness. This resulted in the M60A1 (RISE), with the program completed in 1987.

The next configuration was the M60A1 RISE (Passive). This fire-control upgrade was a significant improvement for night operations since it dispensed with the need to use the active infrared searchlight required by previous night-vision systems. One of the main problems with the use of infrared searchlights was that they were visible to any enemy forces also equipped with infrared viewers. In contrast, the passive night sights did not require active illumination from lights on the tanks. The new passive night-vision systems were based on image-intensification technology that amplified ambient starlight or moonlight to provide the viewer with a usable image. Two different image-intensification sights were part of the package, an AN/VVS-2 passive night sight for the driver and an M35E1 for the gunner. This upgrade package was accompanied by a deep-water-fording kit. The conversion program began in 1977 and was completed in 1987.

During the 1973 Yom Kippur War, the M60A1 was found to be well armored except in the chin area under the front of the turret and the turret ring, which suffered a disproportionate number of penetrations. An additional armor fillet was added under the chin to correct this, and the turret ring casting thickened on new production tanks. This upgrade did not receive a specific designation change. The 1973 war also revealed that the "cherry juice" hydraulic fluid used in the turret traverse system was excessively flammable. If the turret was penetrated and the hydraulic lines ruptured, the pressure in the system sprayed the turret interior with a flammable mist that ignited, burning the crew. The solution was twofold: a new, less-flammable fluid for the turret traverse, and new fire-resistant NOMEX coveralls for the tank crew.



The M60A1 underwent gradual improvements in the 1960s and 1970s. This is an M60A1(AOS) with the thickened turret cheek armor, serving with 4/69th Armor in Germany during training exercises in April 1974. It is painted in the MASSTER camouflage scheme, peculiar to Seventh Army in USAREUR.



The final version of the M60A1 family was the M60A1 RISE (Passive) as seen here from a tank of the 1st Cavalry Division. This introduced image-intensification night sights as well as the RISE engine upgrades. This tank also has the added turret chin armor, introduced after the 1973 Yom Kippur War. (Author)

One of the lessons of the 1973 war was the growing threat of anti-tank guided missiles (ATGMs) on the battlefield. One method to defeat ATGMs was the use of smoke to prevent the enemy missile operator from being able to target the tank. Two systems were adopted to deal with this threat. The M239 smoke launchers were an American derivative of the British type used on the Chieftain tank. The two launchers on either side of the turret fired 12 red phosphorous smoke grenades that within two seconds created an 8–10-yard-high smoke curtain, 30 yards from the tank over a 100-degree arc. This system was intended to provide a nearly instantaneous smoke shield. The package also included externally mounted boxes with additional smoke grenades. Since this system was limited to two salvoes, a more persistent smoke system was also developed based on the system used on Soviet T-55 and T-62 tanks. The Engine Smoke Generator consisted of additional fuel lines routed to the exhaust pipes near the engine turbo-superchargers. The driver was provided with a switch to activate the system. Two solenoids controlled the flow of fuel, which provided a dense white smoke column behind the tank when fuel was vaporized by the hot exhaust pipes. The smoke system program began in 1978 and was completed in 1987.

Another upgrade that started in 1978 was the adoption of a new co-axial machine gun. The existing M219 co-axial machine gun was widely regarded as one of the worst machine guns ever adopted by the US military. It was a very unreliable weapon suffering from frequent malfunctions and its rate of fire was slow. The Army selected a new M240, based on the Belgian FN MAG M58 7.62mm machine gun to replace it, with the upgrades completed by 1984.

As of the beginning of Fiscal Year 1980 (October 1, 1979) the US Army had 5,800 M60A1 tanks, the majority of which were in the active Army, with 21 in the Reserves and 233 in the Army National Guard. Production of the M60A1 RISE (Passive) tank continued until 1980 when it was replaced by the M60A3.

Comparative technical data of M60 tanks

Designation	M60	M60A1	M60A2	M60A3
Crew	4	4	4	4
Loaded weight (tons)	51	52.5	57	57.3
Length overall (in)	372	372	289	372
Width (in)	143	143	143	143
Height (in)	128	128	130	128
Glacis armor (mm)	93	109	109	109
Turret mantlet armor (mm)	114	127	292	127
Turret side armor (mm)	76	140	121	140
Main gun type	M68	M68	M162	M68E1
Gun caliber (mm)	105	105	152	105
Elevation (degrees)	-10 +20	-10 +20	-10 +20	-10 +20
Rounds stowed	57	63	46	63
Co-axial MG	7.62	7.62	7.62	7.62
Rangefinder	coin	coin	laser	laser

Computer	M13A2	M13A2	M19	M13A2
Stabilization	no	no	no	yes
Engine	AVDS-1790-2A	AVDS-1790-2A	AVDS-1790-2A	AVDS-1790-2C
Engine type	diesel	diesel	diesel	diesel
Horsepower	750	750	750	750
Transmission	CD-850-6A	CD-850-6A	CD-850-6A	CD-850-6A
Road speed (mph)	30	30	30	30
Max. range (mi)	300	300	280	280
Fuel (gal)	385	385	385	385

THE MISSILE TANK DEBACLE

The advent of ATGMs in the 1950s led to some consideration to using them as an alternative armament for tanks. For example, the US Army briefly considered using the Dart missile in place of a conventional tank gun on one of the T95 pilots. This approach was usually rejected since the missiles were large and bulky, and as a result, a tank could carry fewer missiles than conventional gun projectiles. An alternative was to mount anti-tank missiles externally on the turret as a supplement to the conventional gun rather than as a replacement. This was considered by the US Army but was eventually rejected since the missiles were vulnerable to detonation if struck by enemy fire. In addition, the first generation of missiles was fragile and prone to damage. Most armies quickly realized that it wasn't necessary to mount ATGMs on tanks but to use light vehicles instead. The US Army mounted its early Dart and SS-11 ATGMs on light trucks, and eventually mounted the second-generation BGM-71 TOW missile on a variety of light armored vehicles, including the M113 armored personnel carrier.

In the late 1950s, the US Army became interested in tube-fired guided missiles that could be launched from a specialized tank gun. The guided missile promised to offer superior accuracy at long ranges to conventional tank guns. A hybrid armament system allowed the tank to use conventional ammunition for most missions, and guided missiles when long-range accuracy was needed.

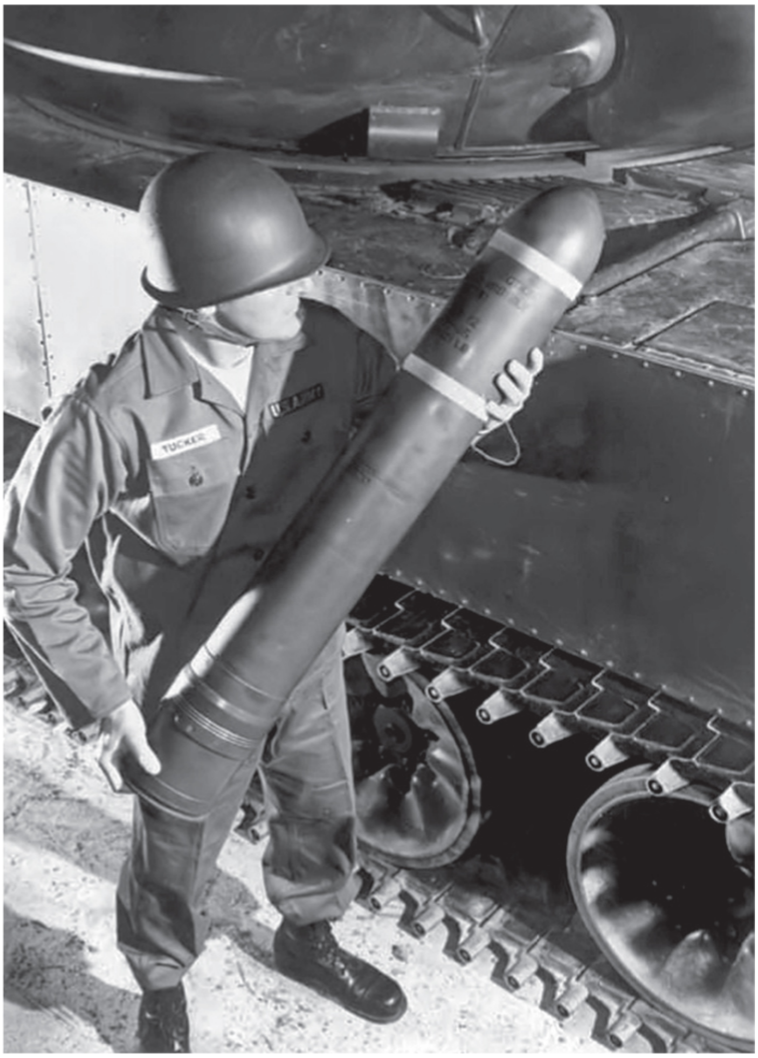
The US Army's 152mm XM81 Shillelagh Combat Vehicle Weapon System (CVWS) missile/gun weapon was based around a 152mm guided missile and a gun/launcher that could also fire conventional high-explosive projectiles. On paper, the Shillelagh missile had an 80 percent probability of a hit on a target at 1,500 meters, while the 105mm gun on the M60A1 firing an APDS round had about a 75 percent hit probability. Furthermore, the accuracy of the conventional 105mm gun dropped off precipitously at ranges over 1,500 meters, while the Shillelagh retained a good accuracy as far as 3,000 meters. The Shillelagh's HEAT warhead also had significantly greater armor penetration due to its large diameter, capable of penetrating at least 150mm of armor at 60 degrees inclination.

Development of the Shillelagh began in April 1958 as a potential armament system for a variety of future tanks, including the joint US/German MBT-70 and the M551 Sheridan. Several competitive designs were offered to satisfy this requirement, including the Polecat guided projectile from the Frankford Arsenal, and guided missile designs from Sperry and Ford-Aeronutronic. The Army issued a development contract to Ford-Aeronutronic in June 1959. The large diameter of the weapon was triggered both by the requirement for a large shaped charge to provide better armor penetration than the conventional 105mm gun, as well as the bulk of contemporary guided missile electronics. Although the centerpiece of the Shillelagh CVWS was the guided antitank missile, the weapon was also expected to fire more conventional unguided ammunition, including HEAT and high-explosive/fragmentation projectiles.

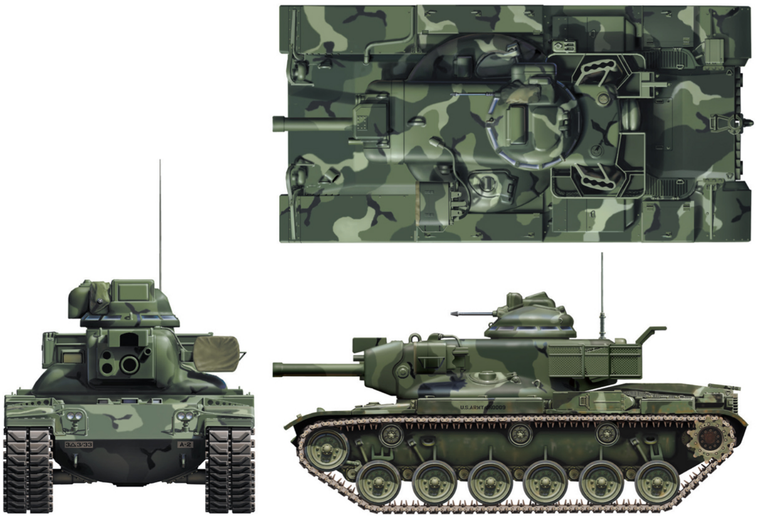
The Shillelagh missile used semi-automatic command line-of-sight (SACLOS) guidance based on an infrared command link. This type of guidance required the gunner to keep the sight on the target, and then the fire control system automatically directed the missile to the target by tracking the missile's infrared flare and sending course corrections via an infrared emitter. This was the second generation of anti-tank missile guidance; earlier command guidance systems required the gunner to actually steer the missile to its target using joystick controls. The second-generation SACLOS system offered a higher probability of hit and demanded far lower levels of gunner training since the guidance system did most of the work. The Shillelagh system presented a major engineering challenge due to the use of its infrared command link. A less ambitious SACLOS system was developed for the contemporary TOW anti-tank missile which used a wire command link. A major technical issue was the interference to the infrared command link caused by the missile exhaust plume and by ambient sunlight. Test launches began in November 1960, with the first guided test firings in September 1961.

The arrival of the new Kennedy administration in 1961, and most notably the new Secretary of Defense, Robert McNamara, accelerated the Shillelagh program. The Kennedy administration placed greater emphasis on US conventional forces, and McNamara's preference for technical solutions to tactical problems encouraged futuristic efforts such as Shillelagh. Since the XM551 Sheridan tank would take time to develop, McNamara supported an effort to initially deploy Shillelagh on the existing M60 tank as the M60A2. The initial guided test launches of the Shillelagh missile in the autumn of 1961 at White Sands Missile Range (WSMR) were disappointing, with only one of 11 launches acceptable. The rocket motor smoke trail overwhelmed the infrared command link, so a new propellant was developed to minimize the smoke trail.

Firing tests of the modified missiles in May–June 1962 were far more satisfactory. The Shillelagh had one inherent weakness due to its infrared command link: it could not be effectively guided if the sun was directly behind the tank's command transmitter in roughly a 40-degree cone. The 1962 tests had been successful enough that Ford-Aeronutronic was awarded an extension of its development contract in January 1963. During the final development flight tests of the Shillelagh missile in September 1963 to October 1964, the missile performed satisfactorily in 58 of 63 launches; ten launches by military crews in September 1964 were successful. The MGM-51A Shillelagh missile was approved for limited production on August 12, 1964.



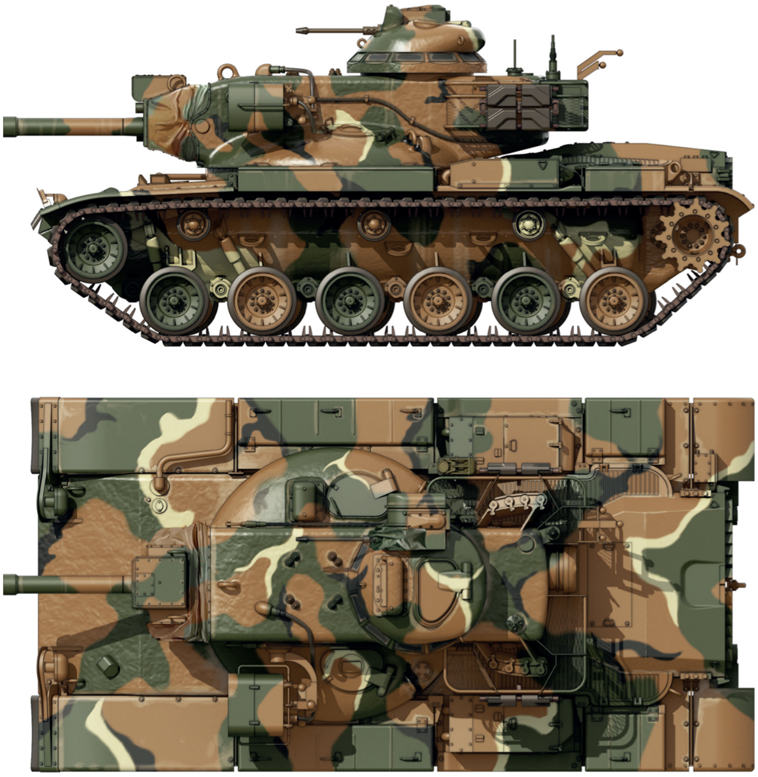
A crewman prepares to load an MGM-51 Shillelagh missile during trials of the XM551 Sheridan. The Shillelagh missile/gun system proved troublesome throughout its short career, leading to the eventual downfall of the M551 Sheridan, M60A2, and MBT-70 tanks.



M60A2 152mm tank, 3/33rd Armor, 3rd Armored Division. (Artwork by Jim Laurier © Osprey Publishing)

The Shillelagh's main problem at this point was its combustible propellant case developed at Picatinny Arsenal. Unlike conventional ammunition which used a metal case, the 152mm gun used a non-metallic case formed of a combustible nitrocellulose wall, which contained the usual grained propellant inside. When the gun was fired, the propellant case and its contents were supposed to be totally consumed in the process. This radical approach had been taken largely because of its connection with the MBT-70 main battle tank program, which had an autoloader and nuclear, biological, chemical (NBC) protection system that required this feature.

The combustible case was much more fragile than metal cases, and so there was a significant risk that it would break open and spill dangerous propellant grain on the turret floor during the loading process. The case tended to absorb moisture and would then swell, and so the case would not properly chamber in the gun. In addition, a damp case would sometimes not combust completely while in the gun chamber, so there was a risk that the subsequent round would come in contact with smoldering residue and prematurely ignite. Catastrophic premature detonations occurred three times during testing from November 1966 to March 1967, and tropical tests in Panama found that there was smoldering residue in the chamber in 39 percent of the firings. The original XM157 case was redesigned for the standard M157 by delivering it in a neoprene bag to prevent the moisture problem; the bag was removed before the round was fired. The M205 third-generation casing entered development in May 1967; it was more rigid and less prone to breaking open. Although the Army considered the obvious solution of using a conventional metal case, this was rejected since it would be incompatible with the auto-loading system of the MBT-70 tank. In the event, the MBT-70 program was canceled in 1971, leaving the M551 Sheridan and M60A2 tanks stuck with this immature technology.



M60A2, 33rd Armor, 3rd Armored Division, Germany, 1975. (Artwork by Felipe Rodríguez © Osprey Publishing)

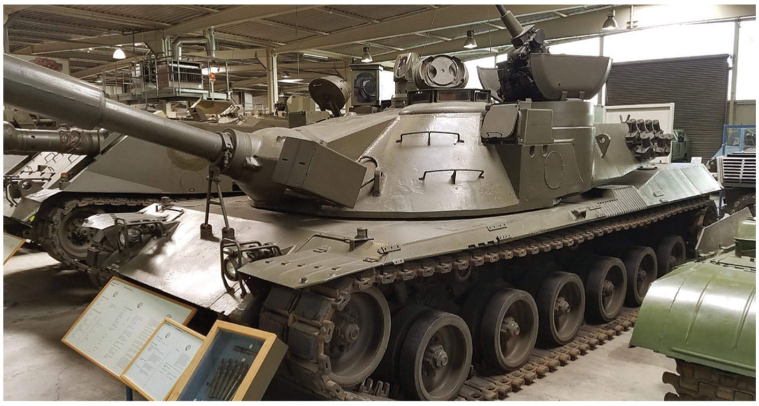
Although the M551 Sheridan and M60A2 remained in service for more than a decade, the problems with the Shillelagh and its associated 152mm gun/missile armament were a lingering source of technical issues that plagued both tanks through their career in the US Army. It is worth noting that no other army purchased either tank type, largely due to this problem.

The US Army was not unique in its interest in guided-missile hybrids. The Soviet Union developed the 125mm Kobra guided missile and used it on its T-64B and T-80 tanks starting in 1976, a decade after the Shillelagh. France also developed the 142mm ACRA missile as an alternative armament for its AMX-30 tank. It proved to be too complicated and expensive and never went into production.

EVOLUTION VS. REVOLUTION (AGAIN)

The US Army regarded the M60A1 as an interim stopgap and little more than a warmed-over M48 derivative. There was still the hope that new technologies could provide a more satisfactory design. By the early 1960s, the old medium tank and heavy tank designations were being replaced by "main battle tank," the idea being that a single design could perform both functions.

In 1961, US Secretary of Defense Robert McNamara discussed future tank requirements with his German counterpart, Franz Josef Strauss. McNamara wanted to develop a new joint process for developing and manufacturing weapons for NATO. He promoted the idea to jointly design a future main battle tank, dubbed MBT-70 or Kampfpanzer 70, with production beginning in 1970. It was hoped that the joint effort would reduce development, production, and long-term operating costs. A joint agreement was reached in August 1963.



Germany participated with the US Army in developing the Kampfpanzer 70 for its future requirements. Its version had many detail differences from the American-built MBT-70. (US Army Acquisition Support Center)

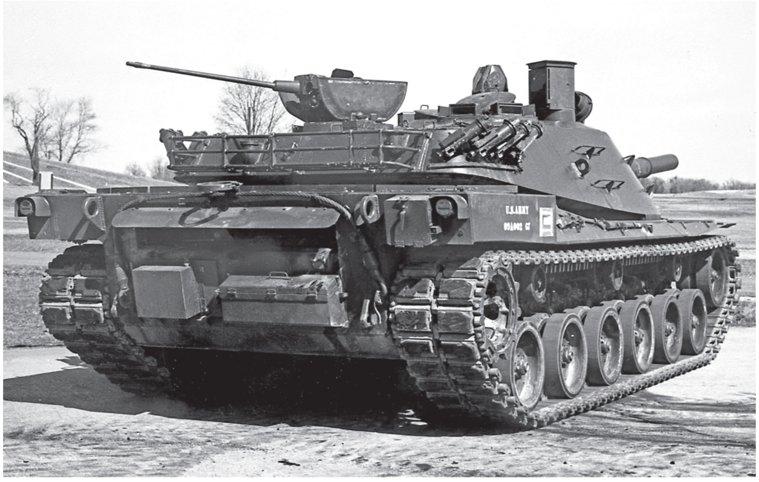
By 1963, General Motors was selected as the American prime contractor, while the Germans selected a consortium called DEG (Deutsche Entwicklungsgesellschaft). The joint design team was originally based in Augsburg, Germany, but in 1966 moved to Warren, Michigan, outside Detroit where US tank development was centered.

The primary design requirements were for fire-on-the-move using an automatic lead angle computation system, stabilized sight, passive night-vision systems, hydraulic turret traverse, full NBC protection within an air-conditioned crew compartment, high-performance engine offering at least 30hp per ton, variable height suspension, and use of welded spaced armor for the hull and turret.

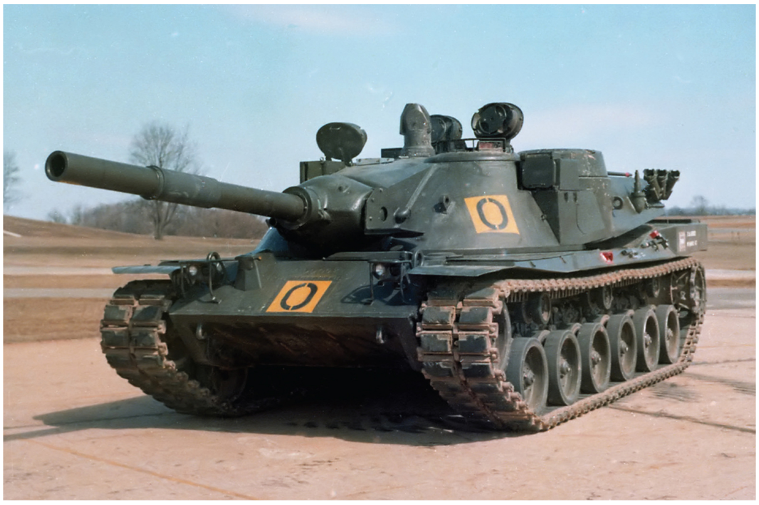
Early design studies examined multiple configurations, including a turret-less casemate design, an unmanned turret with the crew in the hull, or an encapsulated turret with the entire crew in the turret including the driver. Many of these configurations were based on the requirement for a tank that could be hermetically sealed to protect the crew in a contaminated nuclear or chemical weapons environment. By 1965, the design studies were narrowed down to an encapsulated turret configuration. Problems began to arise as both sides tended to favor subsystems that had been locally developed. Furthermore, the US Army regarded the MBT-70 with more urgency than the Germans since the Bundeswehr had recently decided to manufacture the new Leopard I tank. The Germans wanted the tank to be light enough to use 50-tonne bridges; the US Army was content with 60-ton bridging requirements. The Germans wanted more radiation protection than the US side.

The US Army from the outset planned to employ a novel gun/missile armament, promoting the 152mm XM81 Shillelagh. The US Army wanted a weapon capable of engagements at 2,000–3,000 meters. German tank doctrine did not see a need for such range, since the terrain along the German border tended to limit tank engagements to 1,000 meters or less. The Germans grudgingly acquiesced to the US selection but continued to work on a new smooth-bore 120mm gun to deal with future Soviet tank threats.

By 1966, a final mockup had been prepared and the US completed an experimental chassis. The plan was for each side to build eight prototypes, though this was later reduced to six each. The first US prototype was completed in July 1967, followed by the German prototype in October 1967. By this stage, the joint program was starting to unravel. The US favored the Continental AVCR-1100 diesel engine, while Germany favored a Daimler-Benz design. Both sides developed their own hydropneumatic suspensions. When the Continental diesel program encountered developmental problems, the US side began to push a turbine alternative. As the US program manager later complained, “Matters which had been negotiated and agreed upon, would reappear for renegotiation at later dates.” Total development costs more than tripled from the original plans in 1963 to actual costs in 1969 at about $300 million ($2.1 billion in contemporary dollars). By 1968, the cost escalation as well as growing divergence in the two tank designs were threatening the program. With the new Leopard I tank entering service, the Bundeswehr saw no need for a new tank until 1975; the US Army had set a deadline of December 1969.



The MBT-70 incorporated a remote-control 20mm cannon that retracted into the turret when not in use.



The Army attempted to placate Congress by offering an austere version of the MBT-70 called the XM803. By this time, the US Congress was fed up with cost overruns during the program, as well as the tank's inordinately high cost.

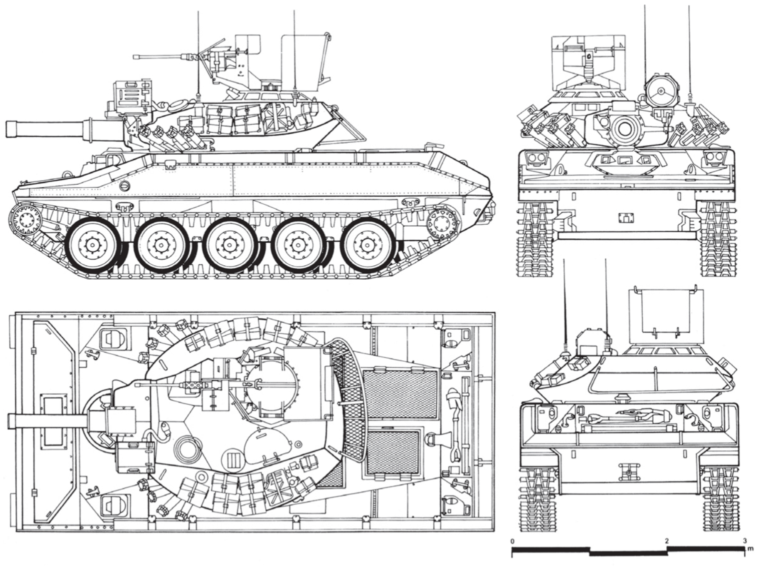
The Germans were the first to admit the obvious incompatibility of goals and intentions. Neither side had been willing to make the compromises necessary to maintain the delicate balance of competing military, political, and industrial interests. In April 1969, the Bundeswehr announced its intention to design and build a new tank radically different than the MBT-70. There was a promise to buy some Kampfpanzer 70s but far fewer than the original agreement. Joint funding of the project was ended, and the two nations papered over the collapse with a promise to "continue the joint program under a policy of maximum commonality consistent with national interest."

Nor was the US Army entirely happy with the MBT-70. Some leaders felt that the MBT-70 program had been pushed by McNamara for its political value more than its technical merits. Lt. Col. Stan R. Sheridan, in a report for the Industrial College of the Armed Forces, complained the "U.S. Army's priority requirements for a piece of equipment must not be sacrificed for the sake of a politically desirable international program." Aside from growing disenchantment within the US Army, the US Congress was unhappy with the escalating development costs. The House Armed Services Committee began asking why the Army couldn't simply put the Shillelagh weapon system in the existing M60 tank instead of the expensive MBT-70. The Army retorted that the MBT-70 could be reconfigured in an "austere" version that would significantly reduce production costs. Under the new Secretary of Defense, David Packard, in January 1970 the collaborative project formally dissolved and the US effort redirected to the "austere" XM803 derivative.

Amid the constrained Army budget due to the costs of the Vietnam War, by 1970 US Army support for the MBT-70 had waned. The Shillelagh missile gun/system was widely disparaged, and there was growing recognition that a new generation of 105mm tank ammunition combined with tank fire control innovations was a better alternative. Cost estimates for the XM803 were three to four times higher than the current M60A1 tank, at $850,000 to $1,000,000 compared with $218,000 to $333,000. With little Army enthusiasm and growing discontent over the cost issues, Congress terminated the program in December 1971. This laid the groundwork for two programs: the M60A2 with the Shillelagh system, and an "affordable" future tank tentatively dubbed the XM815.

M551 SHERIDAN AR/AAV

The initial application for the Shillelagh was the US Army's new light tank program to replace the aborted T92 76mm gun tank. After design studies in 1959, the program began in the summer of 1960 as the M551 Armored Reconnaissance Airborne Assault Vehicle (ARAAV). It was intended to fulfill the dual roles of an armored cavalry light tank and an airborne tank. The Ordnance Tank Automotive Command (OTAC) considered seven armament options for the Sheridan, including 76mm, 90mm, 105mm, and 152mm guns, as well as a hybrid armament consisting of one of these guns supplemented by the existing French ENTAC wire guided anti-tank missile, or a pure missile armament using either the TOW or Polecat missile. The 76mm and 90mm guns offered little advance in firepower, and the TOW and Polecat were far from mature. OTAC finally selected the new 152mm XM81 Shillelagh Combat Vehicle Weapon System. This could still be used with conventional ammunition even if the missile proved unsuccessful, and it offered a major increase in firepower. The Shillelagh was an extremely attractive option since it offered substantially greater firepower than the 76mm gun used in the previous M41 and T92 light tanks, yet at the same time could be mounted on a light vehicle chassis due to the low recoil of the 152mm gun/missile launcher.

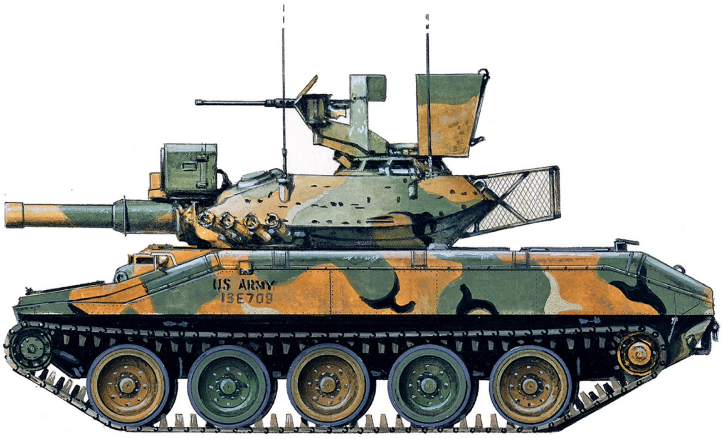


M551A1 Armored Reconnaissance Airborne Assault Vehicle. (Author)

Some 12 industrial proposals were offered, with a design concept from the Cadillac Motors Car Division of General Motors being selected for engineering development. The program began in June 1960 under the designation of XM551 ARAAV General Sheridan, named after the famous Civil War general Phillip Sheridan. Twelve XM551 pilot tanks were built and entered tests in June 1962. The design was extremely challenging due to the strict weight limit desired to make it light enough to be dropped by air delivery, while at the same time incorporating features to permit it to be amphibious. The chassis made extensive use of aluminum to minimize weight.

Due to the novelty of the 152mm gun/launcher, the focus of early Sheridan development was on the turret. A pilot turret was mounted on an M41 light tank hull, and firing tests began at Aberdeen Proving Ground in August 1962 using the conventional 152mm ammunition. The first Sheridan pilots were delivered in June 1962 for testing; the XM551 would go through five major production redesigns during the course of the pilot construction. Much of the redesign was connected to a folding swim barrier that provided the Sheridan with amphibious capabilities. The swim barrier was contained in a cavity around the upper edge of the hull and was designed to fold upward for river-crossing operations, and then fold down inside the hull when not in use. The first three pilots used a unique stamped aluminum road wheel and band track. This gave way to a more conventional concave road wheel and link track on the fourth prototype, and extensive redesign of the hull also took place on this vehicle; three of this second batch of pilots were built in this configuration. The seventh pilot introduced yet the third redesign, shifting from a very substantial swim barrier on the front to a less obtrusive design, and adding a new swiveling driver's hatch. This third batch involved only a pair of vehicles, and with the arrival of the ninth pilot, the fourth batch began to resemble the eventual production configuration, eliminating the bulbous float covers on the road wheels and adding brush-guards over the front headlights. The final pilot and fifth design introduced a modified flexible floatation barrier around the upper edge of the hull to provide the vehicle with a higher freeboard when in the water; this would become the production configuration.

Funding for Sheridan production was included in the FY66 budget, and a multi-year contract was awarded to General Motors' Allison Division on April 12, 1965 to manufacture it at the Cleveland Tank Automotive Plant. The Sheridan was approved as standard in May 1966, despite lingering technical problems. The premature standardization was approved largely due to concern that to do otherwise would lead to the loss of the approved FY67 funding and the cancelation of the multi-year contract, effectively killing the program for purely bureaucratic reasons.



M551, 1st Cavalry, Fort Hood, Texas, 1974. (Artwork by Tony Bryan © Osprey Publishing)

The first two M551 Sheridan tanks were completed on July 29, 1966, and a total of 1,662 were delivered through November 2, 1970. The program cost was $1.3 billion, an 80 percent cost overrun compared to original estimates of $1.05 billion for 2,426 Sheridans. A total of 88,194 Shillelagh missiles were manufactured by Ford-Aeronutronic and Martin at an average cost of $2,665 each.

As late as March 1966, the Army's Test and Evaluation Command (TECOM) at Aberdeen Proving Ground concluded that "as tested, it is not suitable for Army use because of specified safety, durability, reliability, performance, training, and maintenance limits." In June 1967, TECOM conducted tropical trials of the Sheridan in Panama and found that problems with the combustible case ammunition were so serious that Sheridan crews were prohibited from carrying more than a single round of ammunition in the vehicle at one time. This curtailed the deployment of Sheridans beyond trials and training units until early 1968, and hundreds of newly manufactured Sheridans sat idle at depots.

The Shillelagh gun/missile system offered a powerful weapon system that could be adapted to a light vehicle such as the M551 Sheridan ARAAV. This photo shows a 1967 test-firing of the associated MGM-51 missile.

One of the main armament problems with the futuristic Shillelagh gun/missile system was the presence of incandescent particles in the gun tube after firing that could ignite subsequent rounds. The initial solution to the residue problem was the use of an Open Breech Scavenging System (OBSS) that blew carbon dioxide into the chamber. While the system was reasonably effective, it also blew smoldering residue back into the turret, which had the risk of coming into contact with the ammunition. In October 1967, the Army ordered Allison to halt the manufacture of the OBSS for the Sheridan.

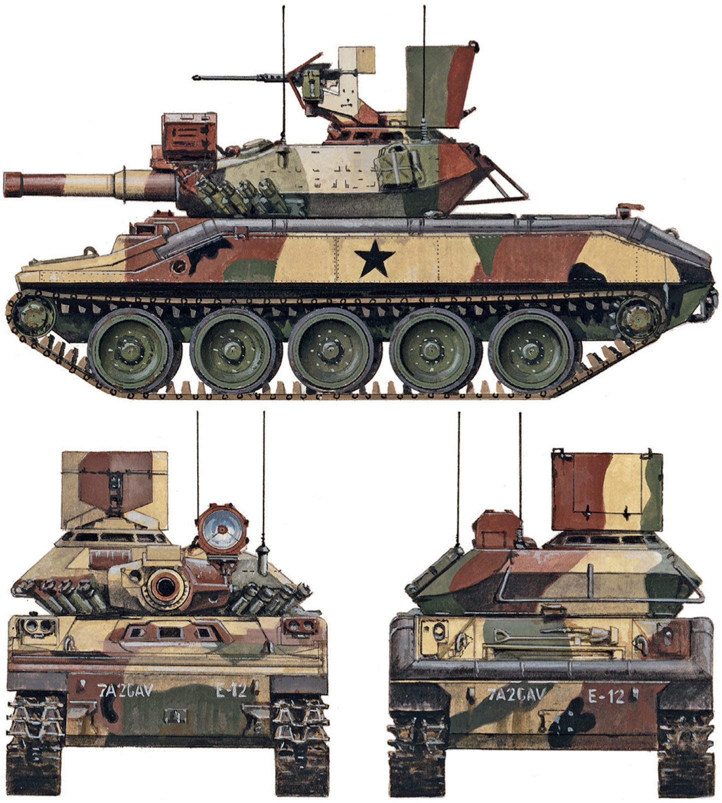
The problems were so serious that there was another round of tests of alternate armament for the Sheridan, including the XM103E7 105mm howitzer and the older 76mm gun; neither was adopted due to the subsequent developments. In late 1967, Allison developed a Closed Breech Scavenging System (CBSS) that consisted of an air compressor and related equipment which blew the chamber clear after firing but before the breech was opened. This was approved for use in January 1968 starting with vehicle 700, but the initial 700 production vehicles remained in storage through much of 1969 until they could be retrofitted. The new system was designated as the M81E1, though it was often called the “152mm Gun-Launcher M81 Modified.”

Due to the space the CBSS took up, ammunition stowage was reduced from 30 rounds to 29. The original ammunition family for the

Sheridan included the XM410 smoke, XM409 HEAT-T-MP (high-explosive anti-tank-tracer-multi-purpose), XM657E2 high-explosive fragmentation, and XM411 training round. The smoke and high-explosive rounds never entered production due to problems uncovered during tests, so the M409 round became the principal conventional combat round aside from the Shillelagh missile. Due to the deployment of the Sheridan to Vietnam, the M625 canister round was developed that contained 10,000 13-grain flechettes. When fitted with the improved M205 combustible case, the two upgraded rounds were redesignated as M409A1 and M625A1.

The Sheridan officially entered service use in June 1967 with 1/63rd Armor at Fort Riley, Kansas. To determine the effectiveness of the new Shillelagh missile, the unit was issued a relatively large number of the expensive missiles and in February 1968 fired 112 Shillelaghs, scoring 88 hits (78 percent). The first use by airborne deployment came shortly after with issue to the 1/17th Cavalry of the 82nd Airborne Division at Fort Bragg.

One of the technical problems to plague the Sheridan was the tendency of the missile system to signal a “no-go” when the check-sight source lamp in the gunner’s M149 telescopic sight was knocked out of alignment after firing the conventional ammunition. Although the developers blamed poor crew training and failure to perform alignment tests, the field commanders were not happy with a system that required such extensive maintenance. The slow pace of deployment and the continual complaints about vehicle reliability led to extensive criticism of the program by the US Congress and several congressional investigations. One influential congressman labeled the Sheridan “a billion-dollar boo-boo.”



M551, 2nd Armored Cavalry, Germany, 1974. (Artwork by Tony Bryan © Osprey Publishing)

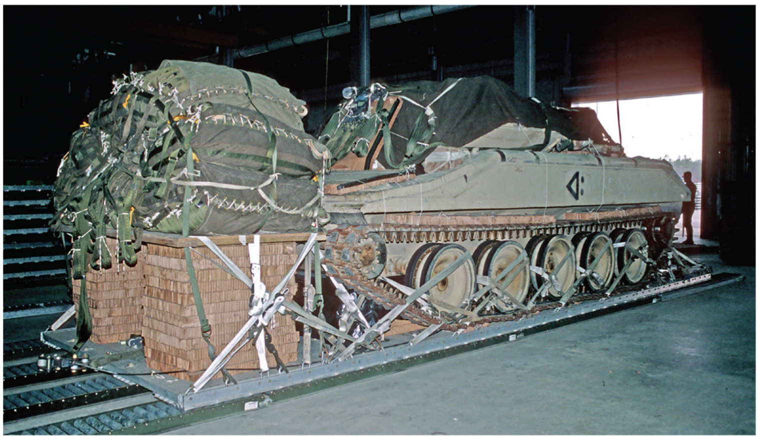
The first deployment outside the continental US was the dispatch of ten Sheridans to the 19th Cavalry in Hawaii in April 1968. Authorization for overseas deployment came in October 1968, followed by authorization for Eighth Army in Korea in November 1968 and USAREUR in January 1969. By the autumn of 1971 there were about 800 Sheridans deployed, including 40 in Korea, 310 in Europe, 250 in the United States, and about 200 in Vietnam. In 1972, 64 Sheridans were issued for the first time to National Guard units in the US.

The Australian army had considered the acquisition of the Sheridan and had tested a single vehicle in 1967–68 but rejected the design as "unsuitable for Vietnam-type conflicts – the only kind of war in which Australia is likely to be involved in the foreseeable future." The US Marine Corps considered it for its light armored combat vehicle program to replace its M50 Ontos but rejected it due to its cost and problems.

AIRBORNE TANK

The 82nd Airborne Division was the only unit to regularly make use of the M551 Sheridan in the airborne role. When first deployed with the 82nd Airborne Division in 1967 for operational trials, the vehicles were attached to 1/17th Cavalry, 3rd Brigade. The 1/17th Cavalry was later transferred to the 101st Airmobile Division, and the 82nd Airborne Division was allotted the 4/68th Armor, which was re-flagged in February 1984 as the 3/73rd Armor.

Three methods were available for air-delivery of the Sheridan: air-landing from a transport aircraft, parachute drop, or low-altitude drop. With the advent of large transports with ramps, such as the C-130 Hercules and C-141 Starlifter, the Sheridan could be delivered if there was a suitable airfield. For forced entry, the other two methods were needed. Parachute drops could be undertaken using the C-130 or C-141 using low-velocity air drop (LVAD) techniques. The Sheridan was packaged on a special pallet, with layers of crushable honeycomb aluminum sheet below and eight G-11A cargo parachutes. A far more dramatic method was LAPES (low-altitude parachute-extraction system). As in the case of more conventional parachute delivery, the Sheridan was mounted on a special pallet with crushable honeycomb below to help cushion the impact. The Sheridan would be carried into the drop area by C-130 Hercules transport aircraft, which would fly as low and as slow as possible over the landing area. A set of extraction parachutes would drag the Sheridan on its pallet out of the aircraft, and it would fall 5–10 feet to the ground at speeds of under 100mph, skidding across the ground for hundreds of feet before finally coming to a halt. This method offered some spectacular opportunities for mishaps, and on more than one occasion, a Sheridan ended up somersaulting all over the landing zone.



All packed up and ready to go! The 3/73rd Armor kept a number of its M551A1 (TTS) Sheridans pre-packaged with their parachutes and airborne pallets at Fort Bragg as part of a ready brigade, able to be rapidly inserted by air around the globe. (Author)

THE ELECTRIC WAR-MACHINE

While the Sheridan was being combat-tested in Vietnam, it was also being issued to armored cavalry units in the United States, USAREUR, and elsewhere, often accompanied by civilian technicians to help iron out lingering technical deficiencies. Sheridan strength in USAREUR went from 309 in late 1971 to 576 at the completion of the deployment program in 1974, equipping 32 troop units.

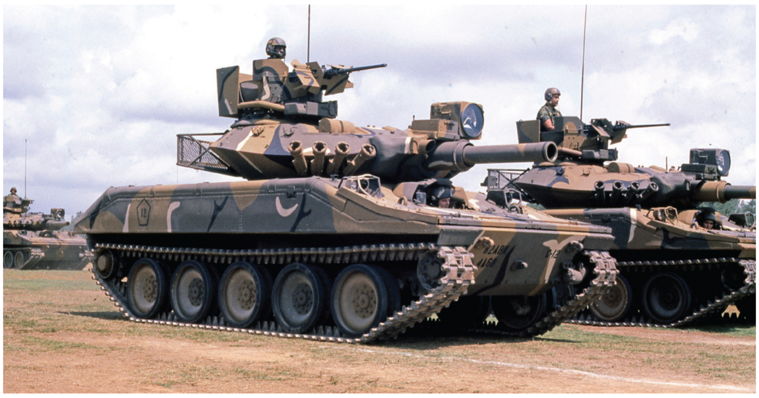
The M551 proved to be a difficult vehicle to tame due to the complexity of its electronic systems in the turret, leading some soldiers to dub it "the Electric War-Machine." The firepower of the Sheridan was fearsome, and the tank leapt up off its first two or three road wheels when the M409 HEAT round was fired. Gunners were instructed to keep their face firmly pressed against the sight when firing to avoid injury, and the standard recognition feature of Sheridan gunners was a perennial black eye. The Sheridan suspension lacked return rollers, and at slow road speeds this set up harmonic vibrations which loosened parts. When subjected to the violence of the recoil when firing the standard M409 HEAT round, bits of the tanks would occasionally come off, including the searchlight, birdcage armor, and various internal components. Shillelagh missiles were seldom fired in peacetime due to their high cost and were usually reserved for special occasions such as exercises at the Grafenwöhr firing ranges.

A patrol of the 11th Armored Cavalry along the inner German border in May 1979 staged by an overly dramatic public affairs officer. The M551A1 ARAAV on the right and M113A1 armored personnel carrier on the left are painted in the Seventh Army camouflage scheme, commonly seen in the mid–late 1970s in Germany.

There were several attempts to improve the Shillelagh and the M81 gun/launcher. The MGM-51B extended-range Shillelagh was developed, which increased the maximum range from 2,000 to 3,000 meters. During initial service, the gun tube was found to have a service life of only 100 rounds due to structural cracks at the muzzle end. Although the M81 used a smooth-bore gun tube, it had a shallow groove that fit a "key" on the missile, which kept the missile in a fixed vertical orientation prior to launch to establish its proper flight regime. By the time it entered service in 1967, the service life of the barrel was raised to 200 rounds by various manufacturing improvements, though the goal was 500 rounds. The eventual solution was to reduce the dimension of the key on the missile, and the "shallow-key" Shillelagh was standardized in January 1968 as the MGM-51C and became the most common version of the missile.

The advent of the Sheridan with its substantial firepower raised the issue of the role of the armored cavalry regiments in Germany. Through the 1970s, their doctrine was debated, with USAREUR leaning toward their use as a potent anti-armor force. This issue was never formally settled, in no small measure due to the short life of the Sheridan in USAREUR.

The Sheridan underwent a series of improvements in the early 1970s to rectify problems and add capabilities. In light of the Vietnam experience, the addition of birdcage armor around the commander's cupola became standard, even in USAREUR. The co-axial .30-cal machine gun was a source of problems, and the original M73 gave way to the improved M71E1, the M219, and finally the M240 machine gun in the late 1970s. The initial production version of the Sheridan lacked an infrared searchlight, relying only on its XM44 image intensification sight. Since this was inadequate on moonless or cloudy nights, the German AEG XS30U searchlight as used on the Leopard I tank was added, starting with vehicle 140. This was short-lived, and most Sheridans received the AN/VSS-3 searchlight.



A parade of M551A1 Sheridans of Co. C, 4/68th Armor, 82nd Airborne Division at Fort Bragg, North Carolina. These tanks have undergone the improvement program, including the birdcage armor on the commander's cupola, the laser rangefinder, and the AN/VSS-3 searchlight. The 4/68th Armor was attached to the 82nd Airborne Division from March 22, 1968, until February 7, 1984, when it was re-flagged as the 3/73rd Armor.

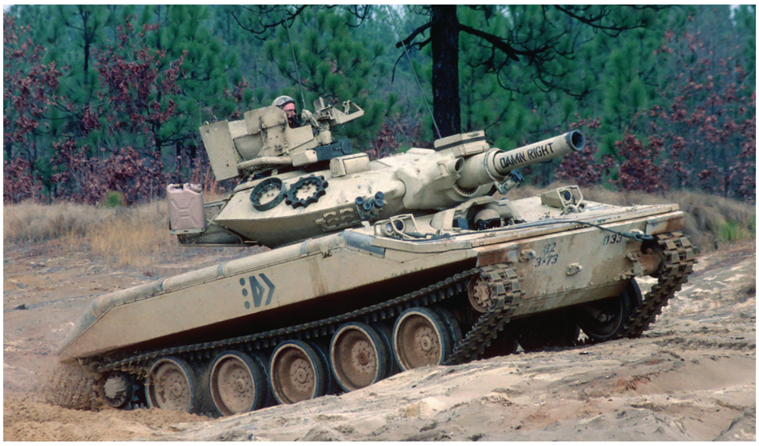
One of the most significant improvements in the Sheridan was the adoption of an AN/VVG-1 laser rangefinder, the first installed on a US tank. The Sheridan had a more urgent requirement for this system than tanks with more conventional guns, as its standard M409 projectile was unusually slow with a pronounced ballistic arc, mandating greater elevation correction than typical high-velocity ammunition. The laser rangefinder was packaged in a small unit placed immediately in front of the commander's cupola and under the .50-cal machine-gun mount. The electronics for the unit were packaged in boxes placed in the rear of the armored birdcage. The laser was not integrated into the gunner's fire controls; the commander lasered the target and gave the range information to the gunner via the intercom. The gunner's telescopic sight was modified into the M127A1 configuration, which had a laser filter to prevent eye damage; the VVG-1 was not eye safe. Approval for the production of 505 VVG-1 came on April 22, 1971, with deliveries beginning in 1972.

The US Army Tank and Automotive Command (TACOM) started a Sheridan PIP (product improvement program) in 1974, and vehicles were modified in 1977–80 with 26 automotive changes, including the replacement of the original 6V53T aluminum block engine with a cast-iron block version.

The Sheridan was never an especially popular vehicle in the US Army despite its firepower. The string of improvements never entirely cured its many reliability faults. Although it was automotively dependable, the massive recoil of its gun/launcher was not compatible with the Shillelagh missile. The Sheridan had an operational ready rate of only 66 percent in June 1974, over five years after initial deployment, and it did not reach the goal of 80 percent until June 1975 after an extensive improvement and training program. By the time it exceeded the USAREUR standard of 88 percent in 1977, its fate was already in doubt. The Army was already planning a new generation of armored cavalry vehicle, first the XM800 Armored Reconnaissance Scout Vehicle (ARSV), and subsequently the M3 Bradley Cavalry Fighting Vehicle, and so there was some debate regarding the fate of the Sheridan.

In the summer of 1977, there was a meeting of the Army Chief of Staff, Gen. Edward "Shy" Meyer, with Training and Doctrine Command (TRADOC) commander Gen. Donn Starry, and Army Materiel Command (AMC) commander Gen. John Guthrie. Starry had commanded the 11th ACR (Amored Cavalry Regiment) in 1970 in Vietnam after it had transitioned to the Sheridan, and he repeated the litany of woes of the Sheridan, recommending its retirement along with the equally troubled M60A2 tank, also armed with the Shillelagh.

Although Guthrie tried to defend the Sheridan, Starry was far more eloquent in his condemnation of the design, and Meyer agreed to retire it with all deliberate speed. Since the M3 Bradley Cavalry Fighting Vehicle was not yet ready, the short-term solution was simply to dump it in favor of the existing M60A1 main battle tank. At the time, there were 867 Sheridans in USAREUR, 535 in the continental US, and 41 in the Pacific in Hawaii and Korea. The conversion of the armored cavalry units in USAREUR began in June 1978 and was completed in April 1979 and in the rest of the Army by 1980. The exception to the retirement plan was a single armor battalion with the 82nd Airborne Division, and a dozen vehicles in service with the National Guard. The "residual fleet" was drawn down to 140 vehicles, the remainder being held in pre-positioned reserve.



The M551A1(TTS) was the final variant of the Sheridan in service, and one is seen here during training with 3/73rd Armor at Fort Bragg in 1991, still in its Operation *Desert Storm* colors. (Author)

Following the retirement of the Sheridan by most of the Army, the 3/73rd Armor at Fort Bragg continued to sponsor some modest upgrades. The troublesome M176 smoke mortars were replaced by a new-generation smoke grenade system developed for the M2/M3 Bradley. The M219 7.62mm co-axial machine gun was replaced by the M240 machine gun, the fourth and final change to this perennially troublesome weapon. In 1989, TACOM initiated a program to improve the Sheridan's night-vision systems. The gunner's fire controls were reconfigured by the substitution of the AN/VSG-2 Tank Thermal Sight

(TTS) from the M60A3 tank, while the driver was provided with a second-generation image intensification night sight derived from the system used on the new M2/M3 Bradley. The upgrade was undertaken at the Anniston Army Depot, where most of the retired Sheridan fleet was stored, and this version was designated as M551A1(TTS). The plan was to complete the upgrade of 70 vehicles by April 1991, but the Iraqi invasion of Kuwait in August 1990 abruptly accelerated the program, since the 82nd Airborne Division was slated for immediate deployment to Saudi Arabia. As a result, the program was completed in only 45 days, with 60 of the Sheridans sent to Saudi Arabia and the rest remaining in the US for training.

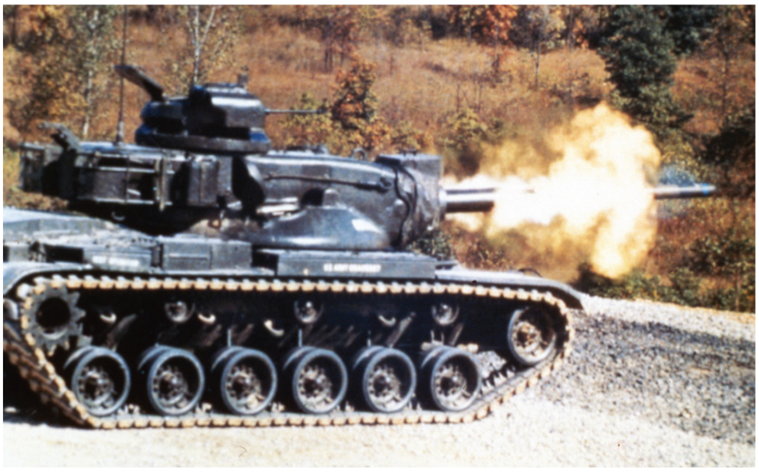
M60A2 STARSHIP

The XM66 was the third tank program with the Shillelagh gun/missile system and was based on the M60 tank. Several turret designs were studied, including a conventional turret similar to the M60A1 and a low-profile turret. The low-profile option was selected, and the program was renamed as M60A1E1 in February 1965. Two development pilots were delivered in November 1965 and February 1966 to begin trials of the XM162 152mm gun-launcher. Like the other Shillelagh efforts, the new gun system suffered from a number of problems. As the program began to reach maturity, the plan was to manufacture M60A1E1 turrets as an upgrade effort for older baseline M60 tanks and to build new M60A1 hulls with the M60A1E2 turret in parallel. The redundant 105mm turrets from the M60 conversions would in turn be cascaded down into a program to improve older M48 tanks into the M48A4 configuration. The delay in solving the Shillelagh problems led to the decision to drop the M48A4 scheme after a few prototypes had been built. Funding in FY66–FY67 was for 243 turrets for the upgrade program and 300 new hulls. The new version was designated as M60A2.

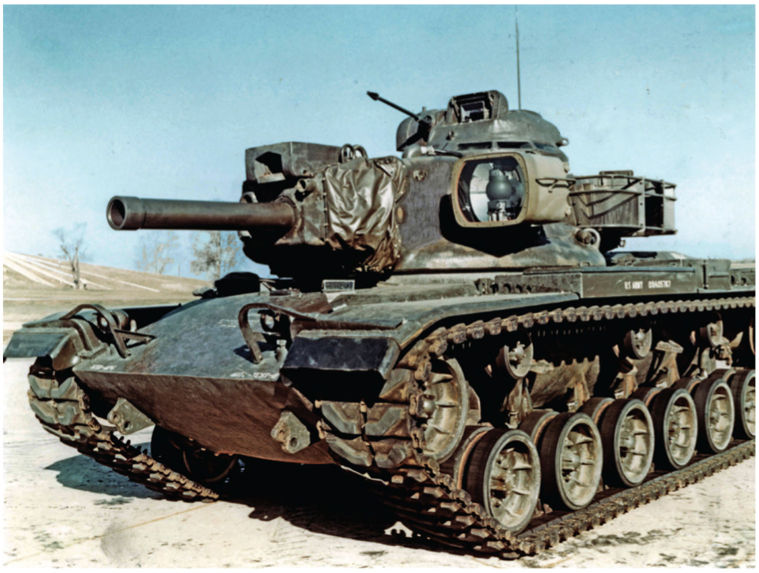
The 1968 production program proved to be premature, as there were lingering problems with the Shillelagh system. As was the case with the M551 Sheridan tank, the M60A2 was eventually fitted with the Closed

Breech Scavenging System (CBSS) to deal with the problem of incandescent residue in the gun tube after firing. The M60A2 used the improved version of the Shillelagh missile, the MGM-51C. The tank was expected to carry 33 conventional rounds and 18 missiles, though the missiles could be replaced by conventional rounds depending on the circumstances.

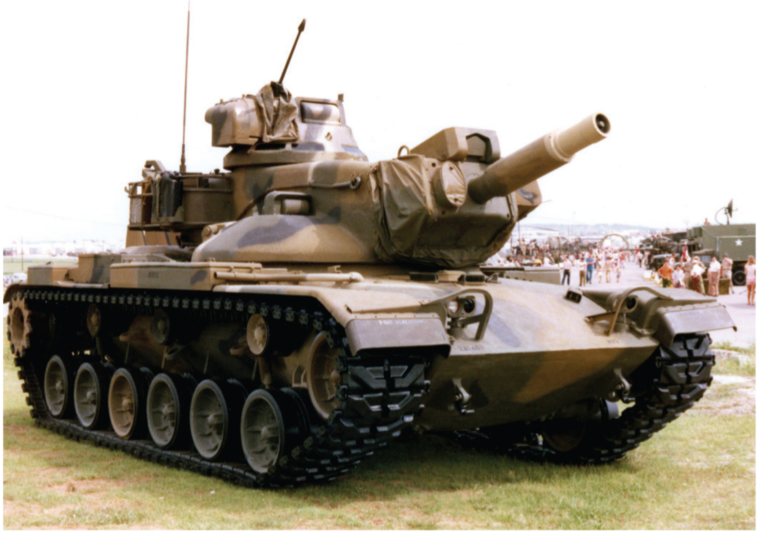
Initial deployment of the M60A2 to US Army Europe units was delayed until June 1975 and was first issued to Co. B, 1/32nd Armor. The M60A2 tanks were used primarily for six tank battalions stationed with the USAREUR in Germany. The complexity of the M60A2 led some crews in Germany to nickname the M60A2 "Starship." Technical improvements in the fire controls on the M60A1 and new ammunition technology lessened the advantage the M60A2 enjoyed in long-range duels. In 1980, the US Army considered rebuilding the M60A2s with M48 turrets and 105mm guns. The M60A2 was withdrawn from service in 1981 and its hulls used for other M60 variants, such as the Armored Vehicle Launched Bridge (AVLB).



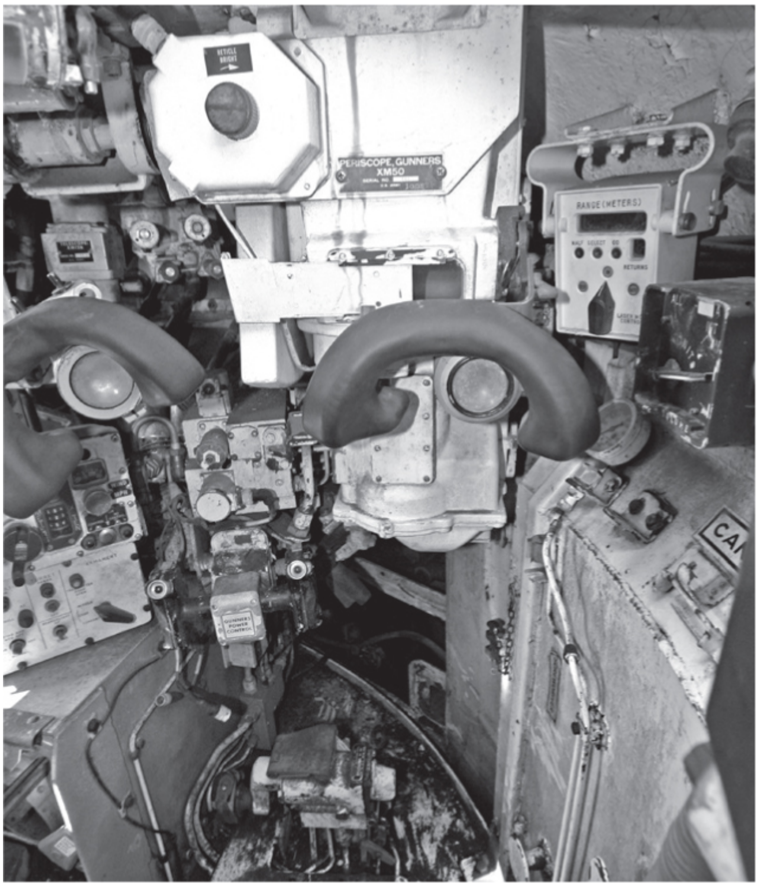
An M60A2 fires an MGM-51C Shillelagh missile during firing trials.



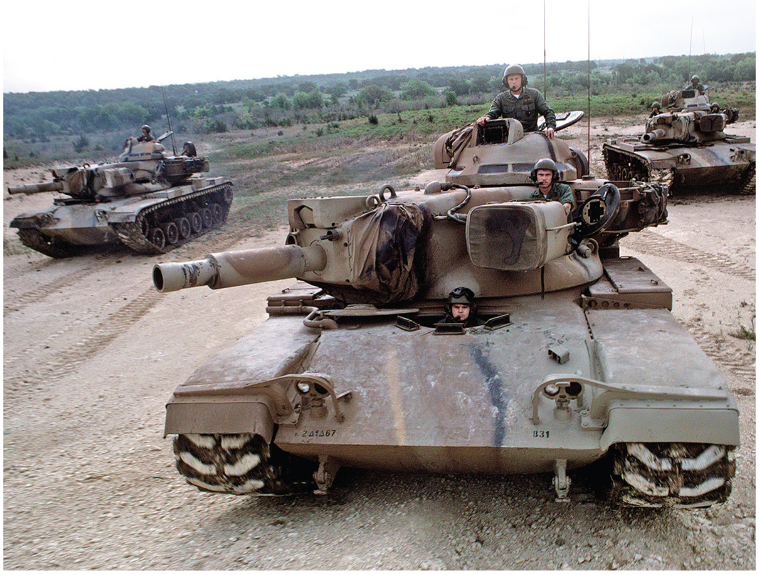
Prior to the introduction of passive image-intensification sights in the late 1970s, US tanks still relied on the AN/VSS-1(V)1 infrared searchlight for night-fighting, as seen on this late-production M60A2 tank. The later-production batch of M60A2s can be identified by the smooth gun barrel without the prominent fume extractor.



An M60A2 of Co. D, 1/67th Armor, 2nd Armored Division, at Fort Hood, Texas, in the early 1970s.


PERISCOPE, GUNNERS
XM50
RANGE (METERS)

A view of the gunner's station inside an M60A2. The complexity of the M60A2 tank's advanced systems led some tankers to dub it the "Starship." (Author)

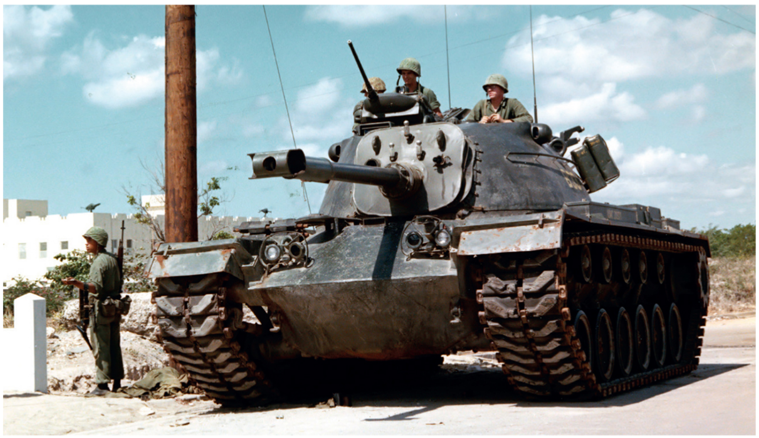


A trio of M60A2 tanks of the 1/67th Armor, 2nd Armored Division, at Fort Hood, Texas, on April 1, 1975, painted in the MERDC grey desert camouflage scheme

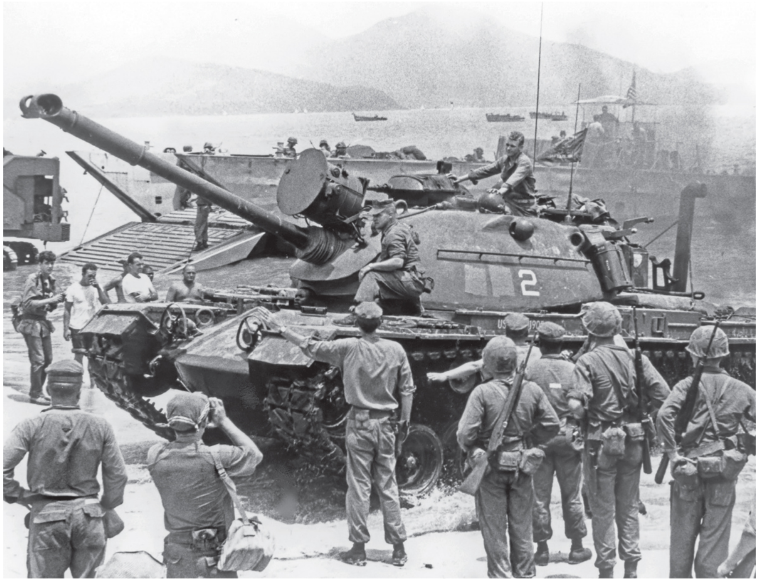
CHAPTER FIVE
US TANKS IN COMBAT 1965–75

THE M48 PATTON TANK IN COMBAT

The first deployment of tanks in combat by US forces since Korea came in July 1958 when M48A1 tanks of the Marine 3rd Medium Tank Battalion were landed in Lebanon as part of the US peacekeeping effort. They saw no serious fighting and later in the summer were joined by the Army's 3/35th Armor, which shared in the occupation duty. In May 1965 Patton tanks of the Marine 2nd Tank Battalion were again landed as part of the US force during the Dominican Republic crisis.



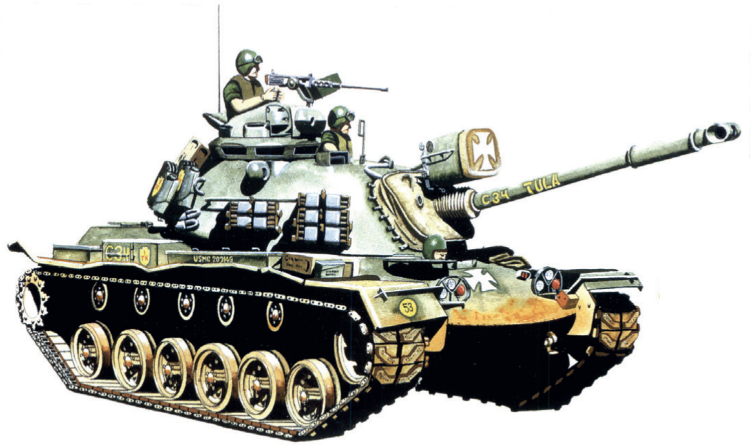
A US Marine M48A3 tank of Co. B, 2nd Tank Battalion, on patrol during the Dominican Republic crisis of May 1965.



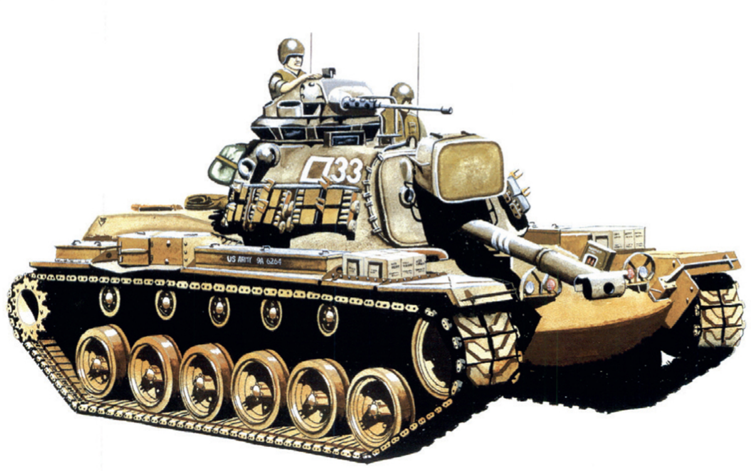
A Marine M48A3 tank comes ashore at Danang, South Vietnam, on March 9, 1965, the first US tanks deployed to Vietnam. This tank is fitted with the 18-inch Crouse-Hinds Model 44676-C incandescent searchlight that was used prior to the more familiar AN/VSS-1 searchlight.

By far the largest combat commitment of US Patton tanks occurred during the Vietnam War. On March 9, 1965, the first Marine M48A3 Patton tanks of the 3rd Tank Battalion landed at Danang, South Vietnam. This was the first US tank unit in Vietnam and it would be joined by the Marine 1st Tank Battalion a year later. The first Army tank unit to arrive in the war zone was the 1st Squadron, 4th Cavalry, in 1965, serving with the 1st Division. Initially, the Army showed little enthusiasm for the deployment of tanks in Vietnam, feeling that they were unsuited to the terrain and the type of unconventional war being fought there. However, experiences with the 1st Squadron, 4th Cavalry, revealed that tanks were useful in supporting mechanized infantry operations and a host of other roles.

Eventually three Army tank battalions would serve in Vietnam: 2/34th Armor; 1/69th Armor; and 1/77th Armor, all with M48A3 Patton tanks. In addition, there were numerous Patton tanks serving in the armored cavalry squadrons. Initially, regimental armored cavalry squadrons contained a tank company with three platoons of five tanks each and two command tanks, one with a dozer blade. These formations were later reorganized, and in 1969 the Patton tanks began to be replaced with M551 Sheridan light tanks as covered in detail from here. The tank battalions had 54 Patton tanks in three companies of 17 tanks (three platoons of five tanks and two tanks in the HQ section) and three tanks in the battalion HQ section. Frequently these battalions were committed piecemeal, with companies assigned to various infantry units or to security duties.



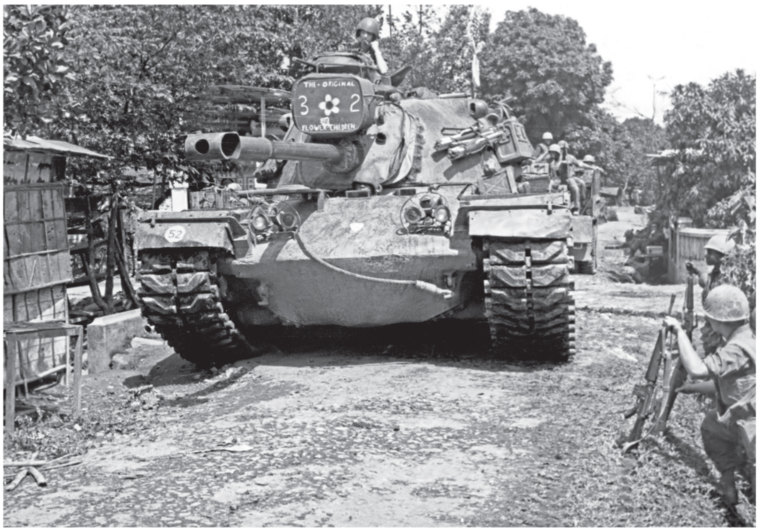
M48A3, Marine 1st Tank Battalion, Vietnam, 1968. (Author)



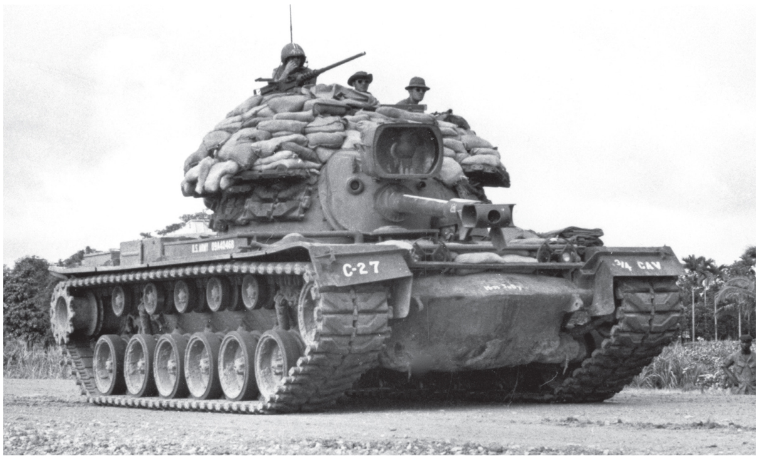
M48A3, 1/69th Armor, Vietnam, 1969. (Author)

Tank tactics in Vietnam reflected the unconventional nature of the war. The Patton provided heavy firepower to bolster infantry actions or could be used to repulse road ambushes on convoy duty. Tank companies would sometimes be assigned to aid in base defense, where their canister rounds could cause a Viet Cong assault to wither. The principal enemy of the tank in Vietnam was not other tanks, but mines. These accounted for over 75 percent of the tank casualties. The other main threat was from infantry anti-tank weapons like the RPG-7.

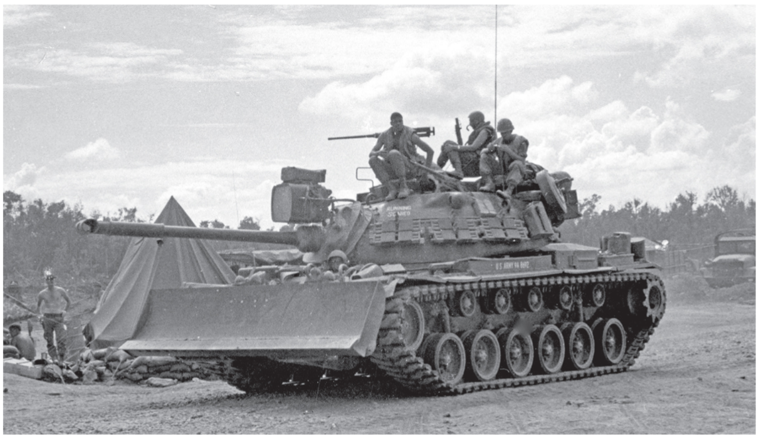
Although not designed for this style of warfare, the M48A3 proved as suitable as could be expected. It was a rugged and durable vehicle and could survive all but the largest mine blasts. The average mine would usually blow off one forward road wheel and some track, and an especially large mine might knock off several wheels and damage the torsion bar housings. If parts were available the tank would often be running by the next day. The Viet Cong eventually began using aerial bombs for mines; for example, in 1966 near Cu Chi, an M48A3 of 1/69th Armor hit a 500lb mine that blew off the rear end and the entire engine, though the crew miraculously survived.



Reinforcements arrive in Hue on February 12, 1968, including this M48A3 Mod. B of the 3rd Platoon, Co. A, 1st Marine Tank Battalion. The name of the AN/VVS-1 searchlight cover is "The Original Flower Children."



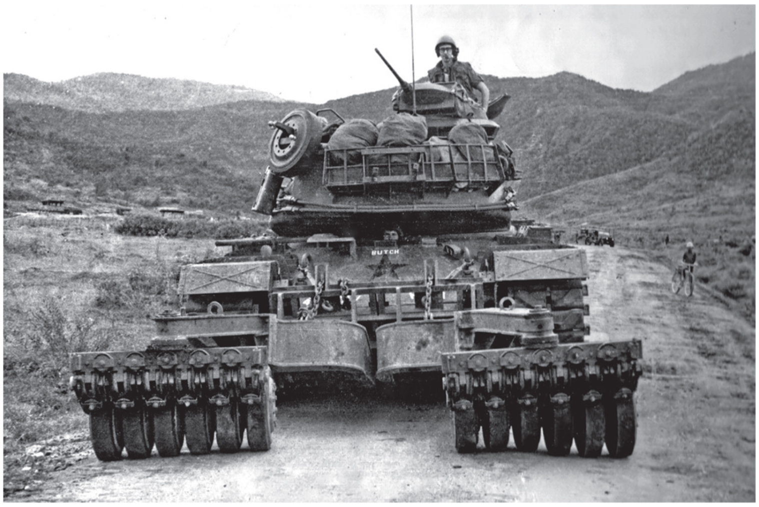
The rocket-propelled grenade threat encouraged local improvisation, such as the sandbag parapet created on the turret of this M48A3 of the 3/4th Cavalry, supporting the 25th Infantry Division in Vietnam in July 1968.



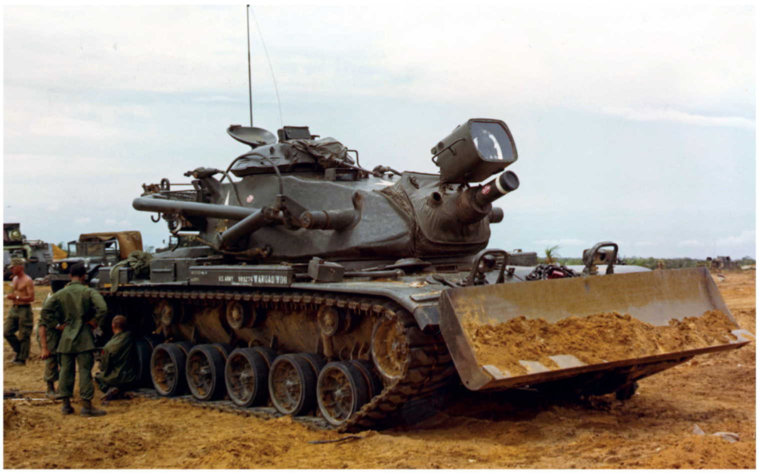
An M48A3 Mod. B with an M8 dozer blade of the 11th Armored Cavalry in the summer of 1968. The crews in some units removed the machine gun from the commander's cupola since it was difficult to use in close combat and instead mounted a .50-cal machine gun externally above the cupola.

The mine problem was serious enough that in May 1967, the USARV (US Army Republic of Vietnam) asked the Pentagon to expedite a tank-mounted mine roller. MERDC (Mobility Equipment Research and Design Command) at Fort Belvoir began developing a series of expendable mine-clearing rollers. Experimental types were shipped to Vietnam in 1968, and based on these trials, six sets of the ENSURE 202 (Expedited Non-Standard Urgent Requirement for Equipment) mine rollers were produced and sent to Vietnam in

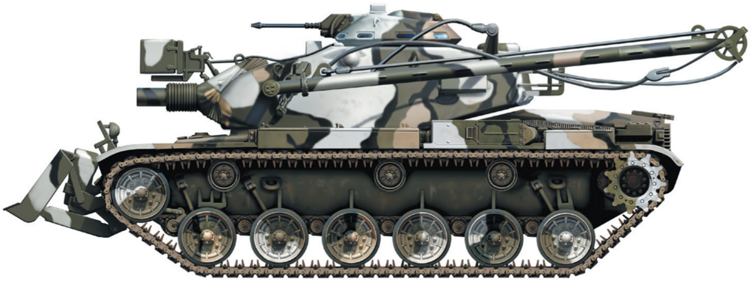
September 1968. This was followed by 21 more sets of the improved ENSURE 202.1. The first sets were delivered to the 11th Armored Cavalry Regiment at Quan Loi on March 8, 1970. The 4th Engineer Battalion mounted one of these mine rollers on an M728 Combat Engineer Vehicle and began road sweeps. Within about ten days, they had encountered five mines, any one of which would have disabled a tracked vehicle and probably would have caused casualties. In each of the five instances, the roller performed as designed. The ENSURE 202.1 was deployed too late and in too small a number to have a significant impact on tank operations in Vietnam.



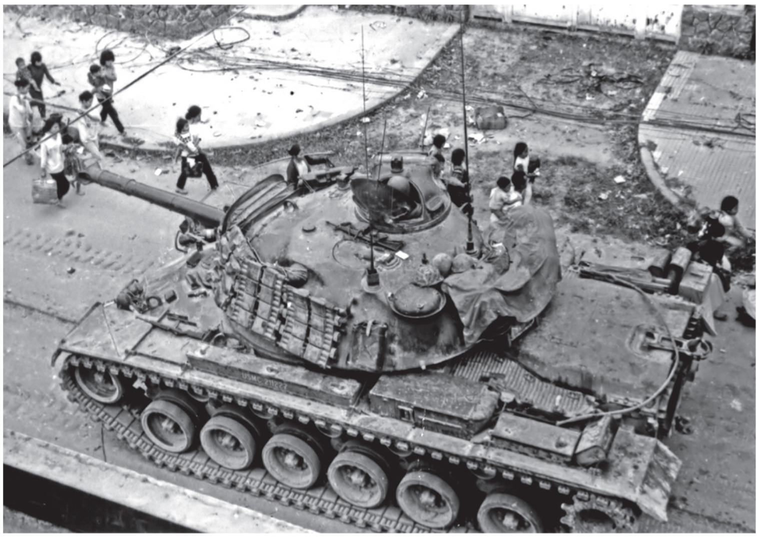
An M48A3 Mod. B named "Butch" of 1/10th Cavalry fitted with the ENSURE 202.1 mine roller during trials along Highway 1 on August 6, 1970.



The only armed version of the M60 to serve in Vietnam was the M728 Combat Engineer Vehicle, armed with a 165mm demolition gun. This M728 served with the 1st Brigade, 5th Mechanized Infantry Division, near Quang Tri in August 1968.



M728 Combat Engineer Vehicle. (Artwork by Jim Laurier © Osprey Publishing)



Vietnamese refugees stream past a Marine M67A2 flamethrower tank of HQ and Service Company, 3rd Tank Battalion, 3rd Marine Division, during the fighting in Hue on February 3, 1968, during the Tet Offensive. For 11 days, two of these flamethrower tanks and two regular M48A3 tanks were the only Marine tanks in the city until the arrival of a platoon from the 1st Tank Battalion.

The M48, like any tank, was vulnerable to RPG-2 and RPG-7 rocket grenades. Some tanks absorbed multiple RPG-7 hits and kept fighting, but a single hit could sometimes ignite stores or ammunition, immediately disabling a tank and its crew. Numerous expedient defenses were attempted to counter the RPG threat, including sandbags and a net of hurricane fence around the turret.

One variant of the Patton used by the Marines in Vietnam was the M67A2, which was an M48A3 mounting an M7-6 flamethrower and a 378-gallon fuel tank. The M67A1 version was based on the M48A2 tank. The flamethrower fired through the false main gun barrel; it had a range of 180 to 200 meters and a duration of 60 seconds between refills. The Army preferred using M132 "Zippos," which were M113 APCs with the same flame equipment.

There was only a single instance of significant tank-vs.-tank combat between US and North Vietnamese Army (NVA) forces in Vietnam. On the night of March 3, 1969, the 16th Company, 4th Battalion, 202nd North Vietnamese Armored Regiment, attacked the US base at Ben Het with infantry, several PT-76 amphibious tanks, and some BTR-50 troop carriers, with the aim of knocking out the M107 self-propelled 175mm guns stationed there. The base was defended by a couple of M42 Dusters and a platoon of M48A3S of Co. B, 1/69th Armor. At around 2100 hours, after artillery preparation, the North Vietnamese forces began their attack. The Patton tanks turned on their infrared searchlights, but these were ineffective due to ground fog. One PT-76 stumbled onto a landmine but continued to fire. Using the PT-76's muzzle flashes as his aiming mark, Spec. 4 Frank Hembree hit it with his second HEAT round, turning it into a fireball. A second PT-76 began firing at Sgt. Hugh Havermale's tank while the company commander, Capt. Dale Stovall, was climbing aboard. A hit on the loader's hatch killed the loader and driver and blew Stovall and Havermale from the tank, but otherwise caused little damage. The tank of Spec. 4 E. Davis blew apart a second PT-76, and heavy volleys from the five Patton tanks drove the NVA troops away after having lost two tanks and a BTR-50. The only other armored vehicle confrontation in Vietnam occurred later in the war, when an M728 Combat Engineer Vehicle mangled an NVA T-54 at close range with a single round of 165mm anti-bunker ammunition.

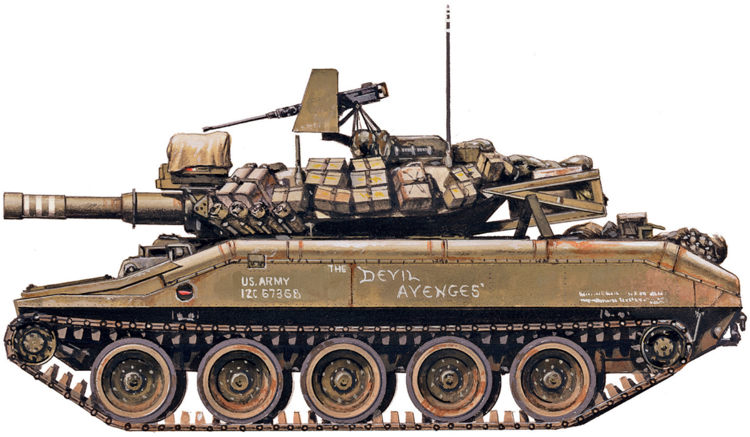
The US Army and Marine Corps relied on the older M48A3 in Vietnam since there was no significant enemy tank threat. This is a tank of the 2/34th Armor, supporting the 25th Infantry Division near Cu Chi on January 23, 1969.

Although the M60 tank was in widespread US Army service at the time of the Vietnam War, the Pentagon saw no reason to deploy it to the conflict since the M48A3 was adequate for the mission. The only version of the M60 tank to see combat in Vietnam was the M728 Combat Engineer Vehicle.

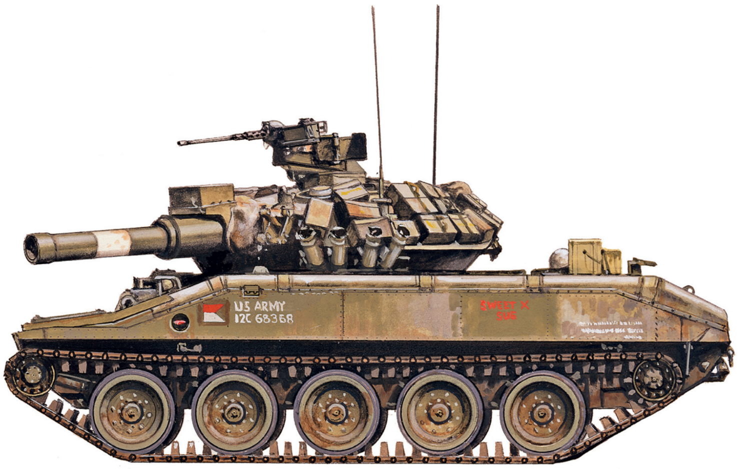
The last US Army unit equipped with the M48A3, the 2/11th ACR, departed Vietnam on April 6, 1972, leaving its tanks behind for the ARVN as detailed later.

THE SHERIDAN IN VIETNAM

The Sheridan had been designed as a high-tech counterweight to the overwhelming mass of Soviet tank forces in central Europe through the use of precise, long-range firepower. It would see its first combat deployment in the low-tech environment of Vietnam minus its essential Shillelagh missile. In 1966, the Pentagon had first offered the Sheridan to the US Army in Vietnam, but at the time the main gun ammunition was unacceptable, and the tankers mocked it as a "$300,000 machine-gun platform." A US Army report on armored tactics in Vietnam in March 1967 foresaw the need for a light tank that had the mobility of the M113 armored personnel carrier but with better firepower. While the M551 seemed the obvious solution, the report questioned the value of the Sheridan in Vietnam due to its lack of anti-personnel ammunition, lack of night fighting capability, weak armor protection, and lack of a dozer kit. The report did not suggest that the Sheridan be modified for Vietnam, but in view of the controversy over the vehicle, OTAC saw this as an opportunity to redeem its controversial design. This led to a crash program to field the M625 flechette anti-personnel round, to develop an anti-mine belly armor package, and to improve the Sheridan's night-fighting capability. In 1968, after main gun ammunition was finally ready, a plan was approved to re-equip the 1st and 3rd Squadrons of the 4th Cavalry in Vietnam, but the unit was opposed to the plan due to the Sheridan's vulnerability to mines and anti-tank rockets compared to the M48A3 tank the unit was using.



M551, 1/11th Armored Cavalry, Vietnam, 1969. (Artwork by Tony Bryan © Osprey Publishing)



M551, 3/4th Cavalry, Vietnam, 1969. (Artwork by Tony Bryan © Osprey Publishing)

The decision to deploy the Sheridan to Vietnam was largely the initiative of Gen. Creighton Abrams, who had been appointed to command US forces in the country in March 1968. Abrams had reluctantly approved type classification of the Sheridan while Army Vice Chief of Staff, and he was aggravated that 1,500 expensive vehicles were sitting unused at depots back in the United States. Abrams ordered the MACV J3 (Plans and Operations, Military Assistance Command – Vietnam) in Saigon to study the issue in July 1968. In view of the controversies swirling around the tank, Abrams wanted opinions from the users, not the developers. So, the Fort Knox Armored School's

Sheridan project officer, the Armor and Engineer Board M551 test officer, and the commander of the 73rd Tank Battalion, where the M551 was in operational field test, were all brought to Saigon to brief Lt. Col. Burton Boudinot, heading the MACV J3 Sheridan project. After several days, the panel unanimously concluded that the M551 was not suitable for Vietnam in its current configuration. Abrams asked if the Sheridan would be of any use at all in Vietnam, and Boudinot suggested that a limited deployment of the Sheridan would be instructive but that only 27 vehicles should be sent, enough for a squadron, shorn of their Shillelagh missiles and complicated fire control system, and reinforced with belly armor due to the mine threat in Vietnam.

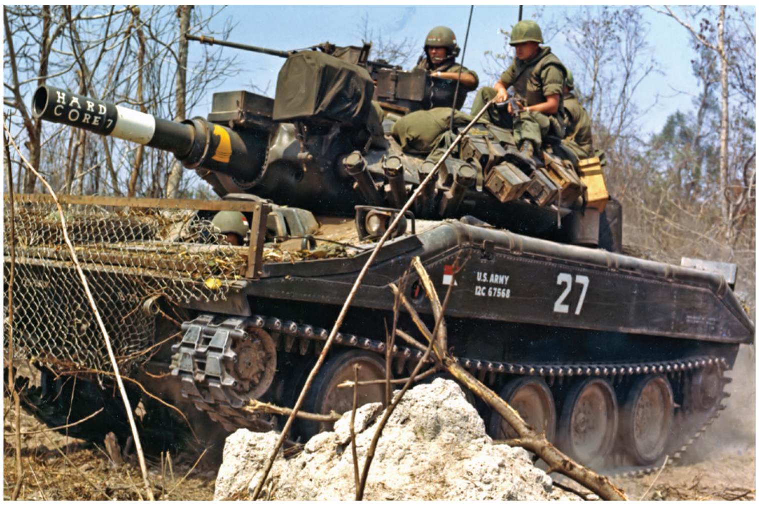
The Sheridans modified for Vietnam were sometimes called "Two Box M551s," as all but two of the electronic boxes connected with the Shillelagh and fire control were removed, the space filled with additional machine-gun ammunition stowage, and the main ammunition racks configured only for conventional ammunition and not missiles. A total of 230 Sheridans were rebuilt or manufactured without the missile subsystem, vehicles 140–223 and 740–885. Abrams mentioned this debate to Col. George S. Patton, commander of 11th Armored Cavalry, who suggested the best test would be to issue the Sheridan to a divisional squadron and a regimental squadron. So, instead of 27 Sheridans, the Pentagon dispatched 64, enough for the use of two squadrons.

The first Sheridans arrived in Vietnam in January 1969 and were issued to the 3/4th Cavalry of the 25th Division and 11th Armored Cavalry Regiment. The 11th Armored Cavalry had until then used a mixture of M113 armored personnel carriers and M48A3 medium tanks, and were not keen on playing around with a lightly armored tank. Opinions changed a bit after the first combat encounter in the pre-dawn hours of January 29, 1969. Two Sheridans were on picket duty along the Long Binh highway when they spotted movement. After switching on the Sheridan's powerful searchlight, they engaged the enemy force with two rounds of the new M625 "bee-hive." The flechettes annihilated the enemy infantry formation, and over 125 dead were found the next morning with evidence that many walking wounded had fled. The M409 HEAT round was also found to be effective against houses and earthen bunkers. Since there was no official doctrine on the use of the Sheridan, both units created their own. The 11th ACR substituted three Sheridans for two M113 ACAVs (armored cavalry assault vehicles) in one of three scout sections per armored cavalry platoon. While this decreased the dismounted scouts in the sections, it substantially increased their firepower. In reality, the units often deployed Sheridans from one section, with several ACAVs from other sections to create a mixed force. The bee-hive round proved to be the most popular projectile in the Sheridan's arsenal; in the first three months of combat, the Sheridans fired 1,461 rounds of bee-hive compared to 350 rounds of M409 HEAT, as well as 431,000 rounds of machine-gun ammunition.

The 3/4th Cavalry swapped Sheridans for M48A3 tanks in its platoons, which proved far more controversial than the 11th ACR pattern. The old M48A3 was widely respected as a durable, reliable tank that was well suited to "jungle busting" due to its weight and horsepower. The 3/4th Cavalry lost its first Sheridan on February 15, 1969, when one ran over a mine, killing the driver and leading to a catastrophic ammunition fire. The squadron "had its confidence shaken," according to a later Army report, since such mines were not as lethal against the much more substantial M48A3. Of the original 64 Sheridans, ten ran over mines within the first three months of operations, but only the first incident led to the total loss of the vehicle. The adoption of the special titanium anti-mine armor plates reduced the vulnerability of the Sheridan drivers to mines, though the mines often disabled the vehicle. After the three-month trial period, the Army in Vietnam was impressed enough with the Sheridan's performance that it would accept several hundred more tanks if certain deficiencies were addressed.

The main cause of Sheridan casualties in Vietnam were the ubiquitous RPG-2 and RPG-7 anti-tank rockets. In their first three months of deployment, 12 of the original 64 Sheridans were hit by RPGs, of which five were total losses. If the RPG penetrated near the turret, there was a significant risk that the combustible ammunition propellant would be hit, often leading to a chain reaction that set off a catastrophic ammunition fire. Such fires completely melted the aluminum armor of the Sheridan hull, leaving little more than a puddle of melted aluminum with the steel turret plopped in the debris. If the crew was inside the turret when this occurred, they had little hope of escaping. Many crews preferred to "ride shotgun" outside the turret than risk being trapped and incinerated inside the turret. The Sheridan turret was small and overcrowded because of all of the internal equipment, and an Army report concluded that "the cramped fighting compartment and high turret temperatures did limit capabilities of the M551 crewmen… [tankers] became fatigued early, crew efficiency was affected, and the sustained firing rate reduced. During prolonged engagements, transfer of ammunition was slow and often hazardous."

The Sheridan was a maintenance burden in Vietnam, especially its complicated turret electronics. Some units grew so exasperated with the constant electrical malfunctions that they jerry-rigged a piece of communication wire between the gun's electrical firing mechanism to the turret dome light so that the main weapon could be fired if the usual methods were blocked by system failures. The humid conditions led to ammunition problems due to the swelling of the combustible cartridge, and in the three-month trial in 1969, 41 misfires occurred. These posed a real dilemma to the crew in combat, since the only way to extract the round was to ram it out from the muzzle end. Several crews suffered casualties doing this while in contact with the enemy. The ammunition was vulnerable to damage from mine shock and vibration, and 140 rounds were damaged during the trials, with the projectile splitting off from the cartridge case. The engine proved to be a frequent source of problems due to overheating, in part due to faulty fan belts as well as the propensity of the radiator and air filters to become clogged in jungle and dusty conditions. Twenty-five engines of the original 64 had to be replaced during the three-month trial.



An M551 Sheridan of the 3/4th Cavalry in Vietnam during its initial combat deployment in December 1969. One of the first field modifications by the unit was to place an anti-RPG screen on the bow of the vehicle using chain-link fence. The Vietnam Sheridans had their missile guidance system removed, dubbed the "Two Box" configuration.

A common improvisation in Vietnam was to relocate the commander's turret control handle to permit the tank commander to traverse and fire the main gun while sitting outside the turret on top of the commander's cupola. Often, the main gun would be pre-loaded with a bee-hive round, which did not require precision aiming to be effective against enemy infantry. The ammunition can feeding the 7.62mm co-axial machine gun in the turret proved to be a source of frustration due to its inadequate amount of ammunition and the tendency to jam. These were quickly replaced by larger cans taken from M48A3 tanks, or spare 20mm ammunition cans from helicopter mini-guns.

The combat and climate conditions in Vietnam required many other modifications to the Sheridan. One of the earliest upgrades was to mount the .50-cal armored shield from M113 ACAVs on the commander's .50-cal machine gun. This eventually led to the development of an armored birdcage, to offer the Sheridan commander better protection. While operating in the heavy bush of Vietnam, the Sheridan exhaust could be trapped near the vehicle, and many crews improvised an exhaust extension from metal artillery transport tubes to duct the exhaust farther away from the turret. Another common modification was the addition of stowage bins on the rear of the turret to compensate for the small stowage rack provided on the baseline vehicle.

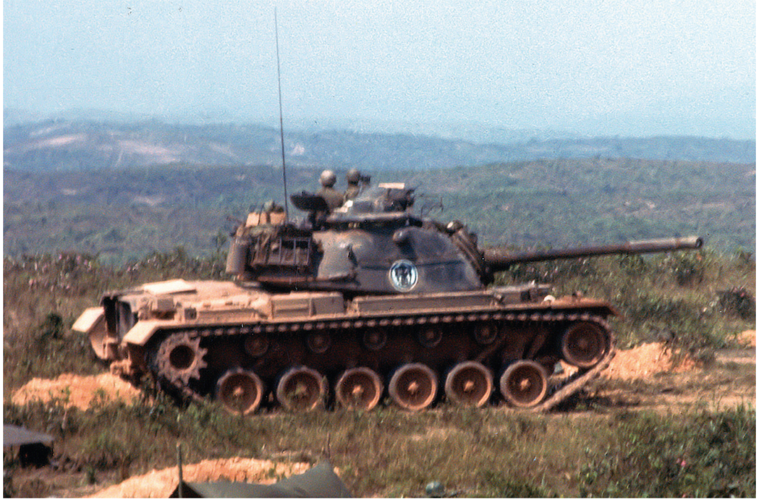
In spite of the numerous difficulties with the Sheridan, it eventually proved to be a useful addition to the armored cavalry when used as a substitute for the M113 ACAV, but not as a substitute for the more robust M48A3 tank. The Sheridan's main advantage was that it was more mobile in soft terrain which the heavier M48A3 could not traverse. As a result, additional Sheridans were shipped to Vietnam for use by other armored cavalry units so that, by 1970, about 200 were in service. In total, some 300 Sheridans were damaged or knocked out in combat, of which about 90 were total write-offs. The Sheridan was never popular in Vietnam, even if it did prove to be a superior source of firepower to the M113 ACAV. Its vulnerability to enemy fire and lingering mechanical and electrical unreliability left it with a reputation as troublesome and dangerous.

VIETNAMESE ARMY PATTON TANKS IN COMBAT

Until 1971 the Army of the Republic of Vietnam was equipped only with M41 light tanks in its armored cavalry units. In July 1971 the first tank unit was formed, the 20th Tank Regiment, equipped mainly with leftover American M48A3 tanks. The unit had a unique organization, having an armored rifle company that rode on the tanks to provide protection from anti-tank weapons. The ARVN crews initially had a great deal of trouble mastering the complex fire control system of the tanks, but by the time training was complete in the spring of 1972 this had been rectified. One of the most serious deficiencies of the unit was the lack of adequate armored support equipment, such as M88 Recovery Vehicles or AVLBs (Armored Vehicle Launched Bridge), and this would cause losses in the later fighting.

In March 1972 the NVA launched its Easter offensive, with two tank regiments among the numerous units sweeping over the DMZ

(Demilitarized Zone) into South Vietnam's northern provinces. The ARVN 20th Tank Regiment was rushed to the area in an effort to stem the NVA advance on Quang Tri. At the time the regiment had 44 M48A3 tanks, some in a poor state of repair, with a pronounced shortage of spare parts. On Easter Sunday, April 2, the 1st Squadron engaged a North Vietnamese armored column from ranges of 2,500 to 3,000 yards, quickly destroying nine PT-76 tanks and two T-54A tanks and breaking up the advance. Over the radio the NVA commander appeared baffled that he had been routed by a force he couldn't even see. It was ample testimony to the fact that the 20th Tank Regiment had learned its lessons well. NVA attacks near Dong Ha were modest until April 9, when the 20th Tank Regiment gutted another NVA attack by knocking out 16 T-54A tanks and capturing a T-59 without loss to itself.



An M48A3 Mod. B of the ARVN 20th Tank Regiment along the Dong Ha line in Quang Tri on April 6, 1973, during the North Vietnamese Army's offensive in this sector. It has the regiment's white and blue elephant head insignia painted on the side of the turret.

A new element was introduced into the fighting on April 23, when an M48A3 and an M1113 ACAV were knocked out by 9M14M Malyutka (AT-3 Sagger) guided anti-tank missiles. The NVA offensive resumed on April 27 with heavy artillery shelling, and the 3rd Squadron lost all its officers and three M48A3 tanks to Malyutka missiles. By the following day, the 20th Tank Regiment had been reduced to only 18 tanks, but not before claiming five more NVA T-54A tanks. By May 2, the regiment had lost all its tanks, some when they were unable to cross rivers, others to mechanical breakdowns, and many during intense fighting.

Following the 1973 ceasefire, the 20th Tank Regiment was re-formed along with two other units, the 21st and 22nd Tank Battalions, with M48A3 tanks. There were also a number of Patton companies formed which served with the ARVN armored cavalry units. Although the South Vietnamese tankers proved to be better trained and more skillful than their NVA counterparts, during the 1975 invasion they were outnumbered in tanks by more than two to one, and overwhelmed. Most of the tank units were lost in the initial fighting in the northern provinces, and few of the 352 M48 and M41 tanks survived these battles.

The NVA recovered many knocked-out M48 tanks after the war. By cannibalizing wrecks for spare parts, they were able to put small numbers back into their own service.

THE PATTON TANK IN FOREIGN HANDS

The M48 tank saw extensive combat use in foreign hands. The Pakistan army was provided with 230 M47 and 202 M48 tanks in the mid-1950s and sent many of its tank officers to Fort Knox for training. These tanks were heavily involved in the 1965 war with India, where there were several large-scale tank-vs.-tank confrontations.

Israel received about 200 M48A2 and M48A2C tanks from Germany in 1964, and these saw extensive combat in the 1967 Six-Day War. There was a string of encounters with NATO's Cold War bogeyman, the Soviet IS-3 Stalin heavy tank, during fighting with the Egyptian army in the Sinai Desert. By this stage, the IS-3 was old and decrepit and proved to be no match for the M48A2 in spite of its thick armor. The Israeli army obtained additional M48 tanks after the war as well as the newer M60 tanks. The Israel Defense Force (IDF) made numerous upgrades to the M48 and M60 tanks, including the substitution of the 105mm gun for the 90mm gun on the M48. These tanks were locally called the

Magach in Israeli service and saw extensive combat in subsequent wars, notably in the 1973 Yom Kippur War.

The other combatant in the 1967 Six-Day War with Patton tanks was Jordan. The Jordanian army received 396 Patton tanks from the US, including 49 M47, 197 M48 and 100 M48A1 tanks. The Israeli army considered the Jordanians to be the best tankers of their Arab opponents in the 1967 war. Jordanian tank losses in 1967 were 171 tanks, of which about 40 were British-supplied Centurion tanks and the remainder M47 and M48 Patton tanks. The Jordanian army was resupplied by the US after the war, bringing its strength up to 283 M48 tanks of different types.

Another country to make extensive use of Patton tanks in combat was Iran. The Shah's government obtained about 400 M47 tanks in the late 1950s. In the 1960s, the US assisted in setting up a tank upgrade plant at Masjed-Soleiman. The resulting M47M included a new AVDS-1790-2A diesel engine, CD-850-6A transmission, and a number of other improvements. All of the Iranian M47 tanks underwent this upgrade program as well as 147 M47s from Pakistan. Following the overthrow of the Shah, a program to upgrade the Jordanian M47s and M48s fell through. The Iranian M47M tanks were used extensively in the Iran–Iraq War of 1980–88.

The M47 and M48 saw small-scale use in many other conflicts, including the use of the M47 by France in the 1956 Suez landings, border fighting between Thailand and Vietnam in 1979, Turkish Army use in Operation *Attila* on Cyprus in August 1974, and in Somalia during its civil wars.

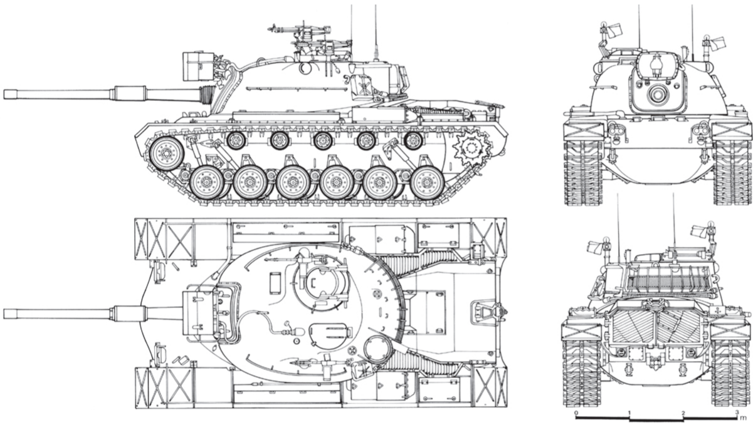
CHAPTER SIX
US TANKS POST-VIETNAM

M48A5 105MM TANK

In the mid-1960s, there was a plan to retrofit older M60 tanks with M60A2 turrets, releasing a number of 105mm gun turrets. Delays in the M60A2 program resulted in the project being canceled, however.

Serious production delays in the M60A2 program, and inventory depletion due to large shipments of M60A1 tanks to Israel in the wake of heavy tank losses in the 1973 war, left the US Army short of battle tanks at a time when the Soviet Union was greatly increasing its own tank force with T-62 tanks. As an inexpensive expedient until M60A1 production proved sufficient, it was decided to modernize mothballed M48A1 and M48A3 tanks to bring them up to M60 standards. These new vehicles were called M48A5. The basic upgrade for the M48A5 was the addition of the M68 105mm gun. The initial conversions based on the M48A3 (serial numbers A3001 to A3999) retained the M1 commander's cupola and the G350 turret riser, with the AVDS-1790-2A engine and added new ammunition racks, a new turret basket, T142 track, and other improvements. The subsequent series, called M48A5 (Low Profile), was remanufactured primarily on old M48A1 tanks and so required a more extensive modernization including the AVDS-1790-2D engine. These used an Israeli-manufactured Urdan low-profile cupola reminiscent of the old M48 type and two M60D 7.62mm pintle-mounted external machine guns. In 1975–79, Anniston Depot carried out about 2,050 of these conversions, of which 1,573 were for the Army National Guard and for Army tank battalions in Korea; the remainder were for export.

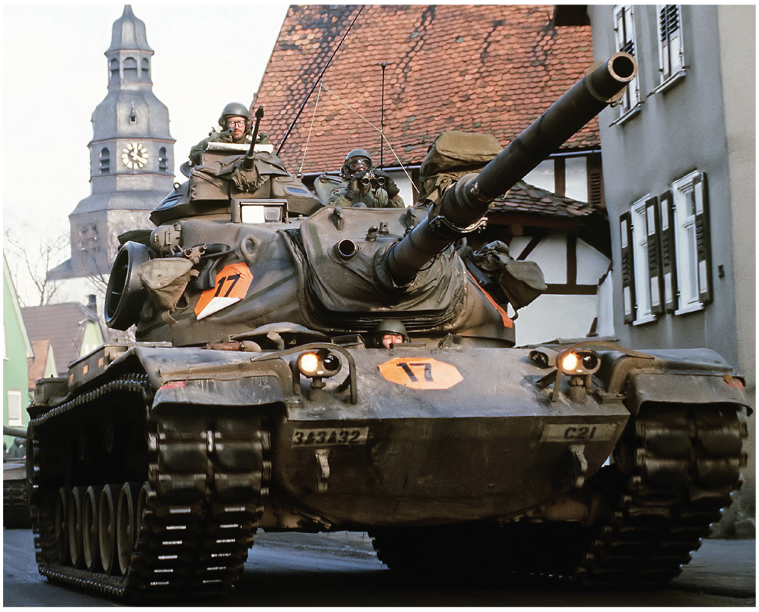
The M48A5 was a modernized version of older M48A1 and M48A3 tanks with the 105mm gun. These are M48A5 (Low Profile) of the 1/110th Armor, 50th Armored Division (National Guard) on the gunnery ranges at Fort Drum, New York, in the summer of 1977.



M48A5 (Low Profile) 105mm tank. (Author)

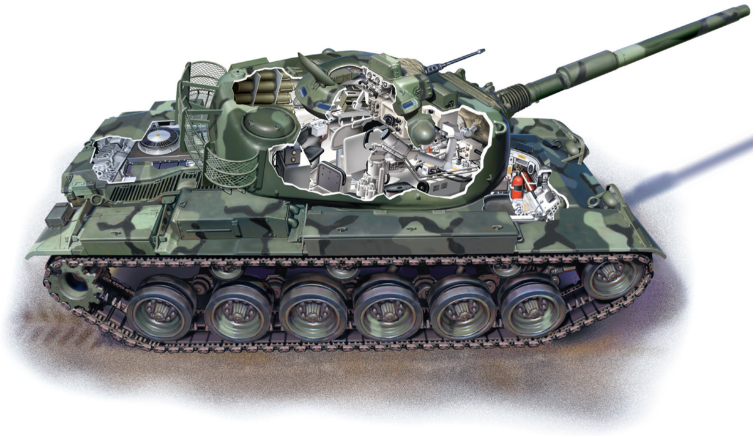
M60A3 TTS

The continuing problems with the Shillelagh system prompted the Army to develop a more conventional product-improved M60A1 under the designation M60A1E3, later designated as M60A3 when accepted for service. This version offered a substantial improvement in the fire controls of the M60A1 tank. It was the world's first tank fitted with a thermal imaging gunner's sight, the AN/VSG-2 TTS (Tank Thermal Sight). As in the case of image-intensification night sights, the TTS was entirely passive, but sensed infrared wavelengths rather than light in the visible spectrum. This was advantageous for tank fighting since the image-intensification sights had mediocre performance on moonless nights or when cloud cover blocked starlight. The thermal sight worked under all weather and light conditions. Also, it facilitated target acquisition, since an enemy tank gave off more infrared energy than the natural background, due not only to its engine, but also to infrared heat energy from tracks, wheels, and residual daytime heating. As a result, enemy tanks tended to stand out from the background in a clearer fashion than when using image intensification sights. This new generation of tank electronics considerably increased tank prices, with the TTS accounting for more than a quarter of the price of the tank.

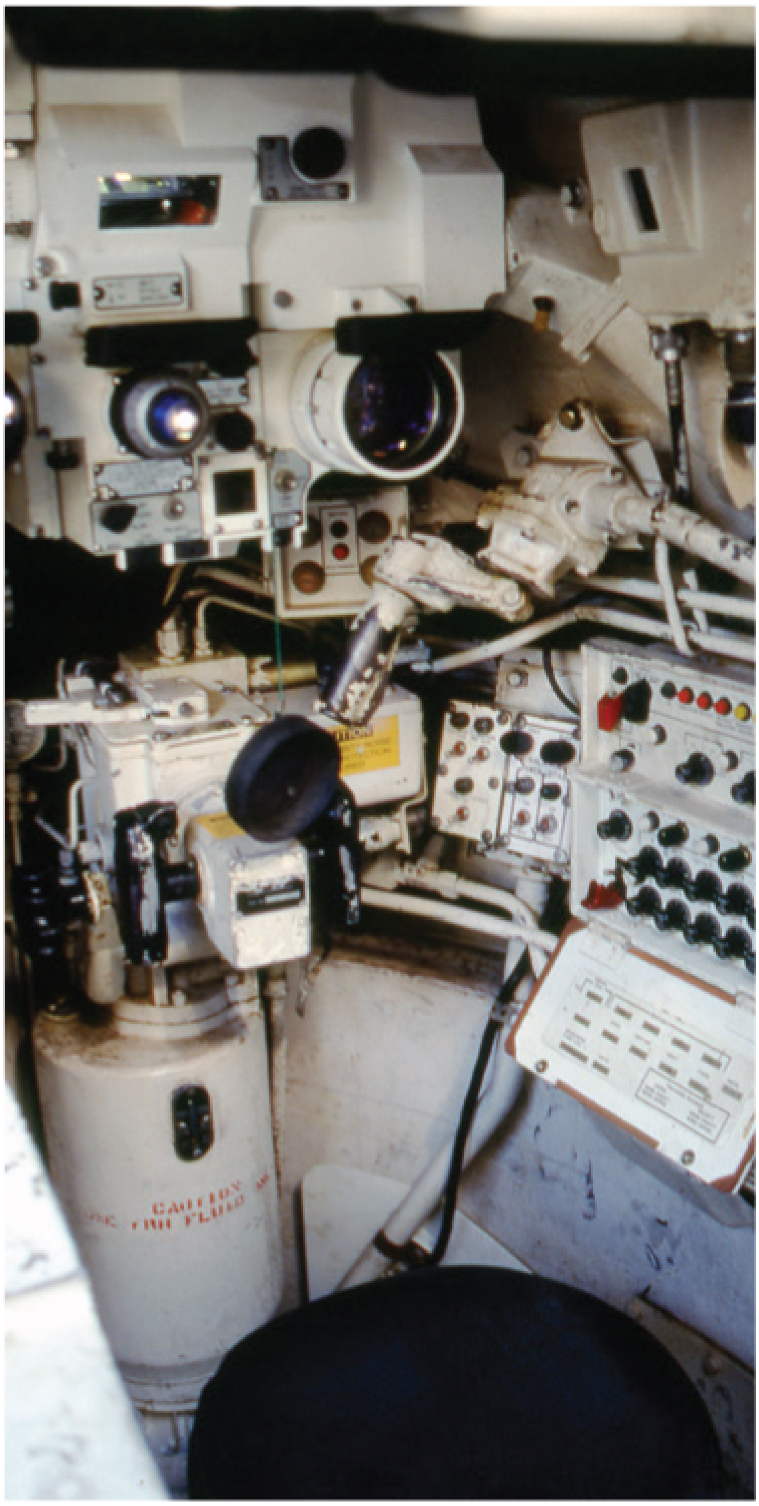


An M60A3 of the "Iron Dukes," 3/32nd Armor, passes through the village of Langgöns in West Germany during the Reforger exercise of 1985 with the steeple of the Evangelische Jakobuskirche in the background. The Iron Dukes served with Force Orange during the maneuvers, hence the temporary exercise markings.

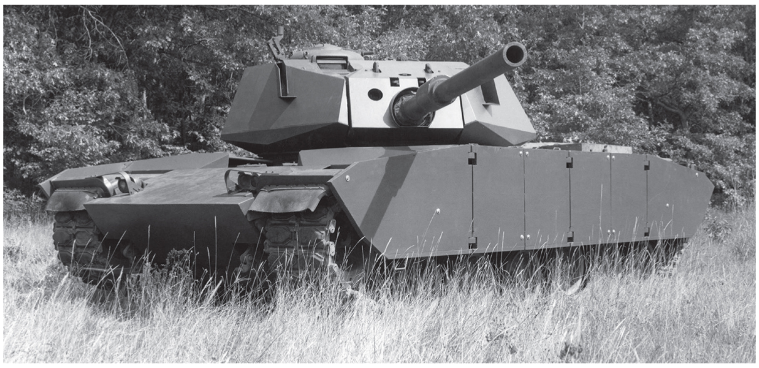
Besides the TTS, the M60A3 introduced fire control upgrades, including the M21 solid-state computer, a muzzle reference system, a cross-wind sensor, and the AN/VVG-2 laser rangefinder. There were also a number of other improvements, including tube-over-bar suspension upgrades, a halon fire extinguisher, reconfiguration of the ammunition to reduce its vulnerability, smoke grenade dischargers, and a thermal shroud for the gun barrel. By March 1980, about 335 M60A3 had been completed, but they had not been issued to units due to delays in the manufacture of the new fire control systems.



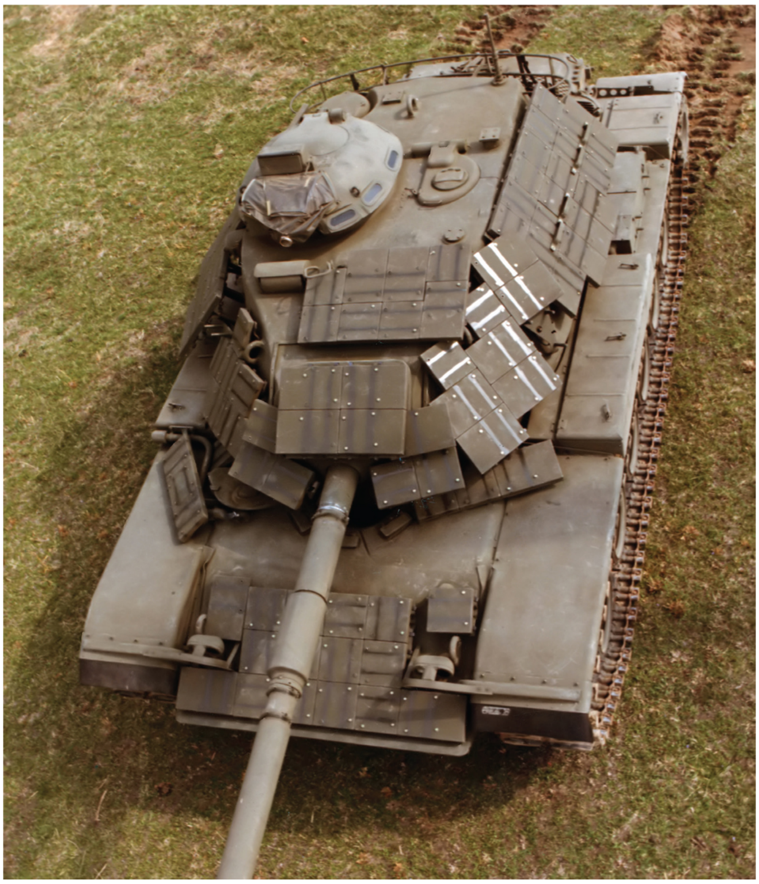
M60A3 105mm tank. (Artwork by Jim Laurier © Osprey Publishing)



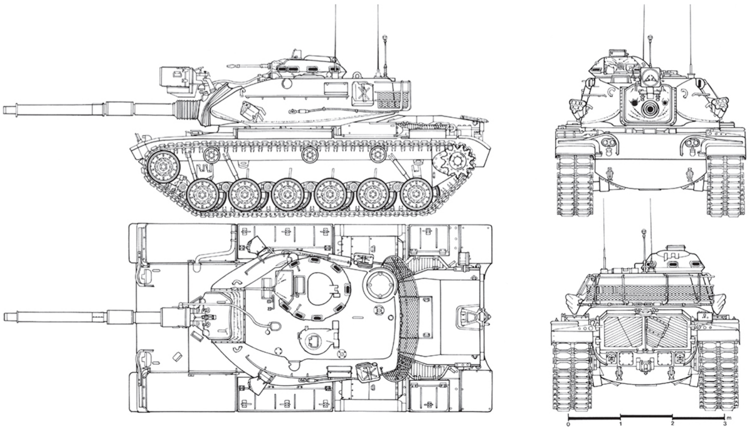
A view of the gunner's station in an M60A3 tank. (Author)



The Super M60 was a Teledyne Continental private venture in the early 1980s to upgrade the M60A1 with advanced armor and improved fire controls for potential export customers. It never progressed beyond prototypes.

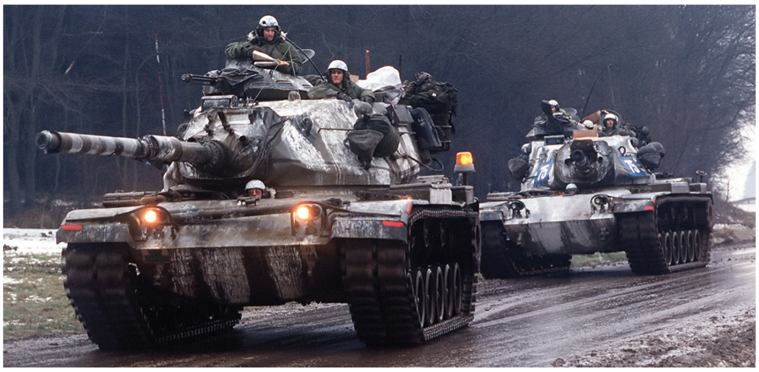


In the mid-1980s, the US Army completed the development of an explosive reactive armor kit for the M60 tank. Officially called Appliqué Armor, it consisted of 52 M1 and 43 M2 armor tiles. This is one of the prototypes of the kit fitted to an M60A3 tank. In the event, it was not widely deployed by the US Army since the M60A3 was being replaced by the M1 Abrams tank in regular Army battalions.

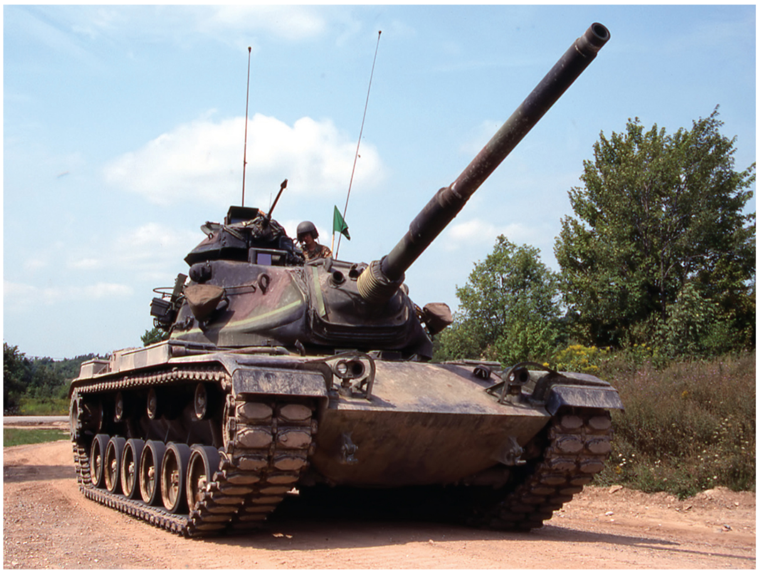


M60A3 105mm tank. (Author)

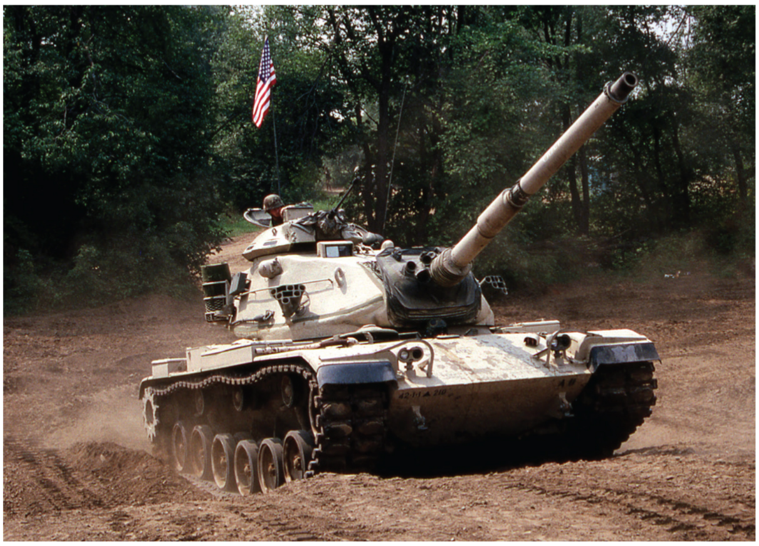
The first M60A3 tanks were funded under the FY78 budget, but technical problems with the fire control system delayed delivery. Initial field tests of the M60A3 began in December 1979; by 1980, it was delivered to the 11th Armored Cavalry Regiment, the 1/ and 3/32nd Armor, 3rd Armored Division, and 1/70th Armor, 8th Infantry Division. US Army Europe was equipped with the M60A3 by the summer of 1983, followed by units in the United States and Korea. The US Army planned 7,726 M60A3 tanks, including 1,902 new production tanks and the remainder converted from M60A1 tanks. This was reduced due to a decision to cap the M60A3 fleet at 5,400 tanks. This left about 1,950 M60A1 tanks in war reserve.



An M60A3 of 4/69th Armor in temporary winter camouflage during Central Guardian, a phase of Exercise Reforger '85, on January 22, 1985, near Giessen, West Germany. This unit took part in the exercise with Force Blue, and so had temporary blue maneuver markings.



An M60A3 of the US Army National Guard in the standard NATO three-color camouflage at Fort Drum, New York, in August 1990. (Author)



An M60A3 of the 210th Armor, New York Army National Guard, at Fort Drum, New York, in August 1990. (Author)

Although all US Army M60A3 tanks were planned to be fitted with the TTS thermal sight, some M60A1 tanks were upgraded to M60A3 standards for export, minus the TTS. These were designated as M60A3 Passive, referring to the use of passive image-intensification sights instead of the TTS. Tanks fitted with TTS sometimes were called M60A3 TTS to distinguish the two types. The last M60A3 for the US

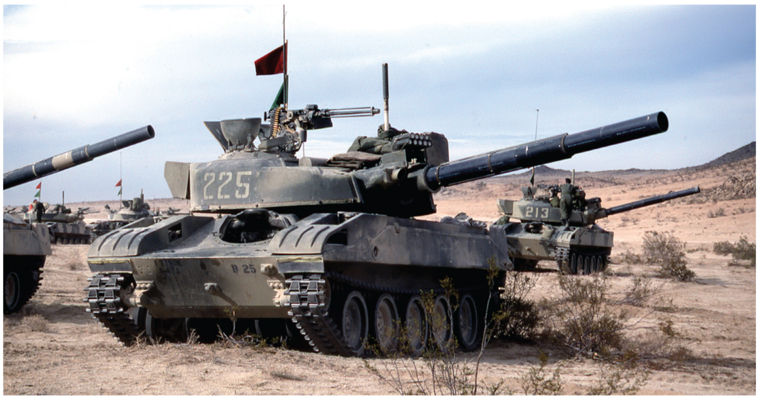
Army were produced in 1985, but M60A3 production continued until 1987 for export customers, including Egypt and Saudi Arabia.

The Army considered upgrading the M60A3 under its M60A3E1 Tank Gun Enhancement Program in 1986. This substituted the lengthened XM24 105mm gun tube that permitted use of the new XM900 APFSDS projectile. In the event, the program was short-lived in favor of developing improved ammunition for the existing 105mm gun.

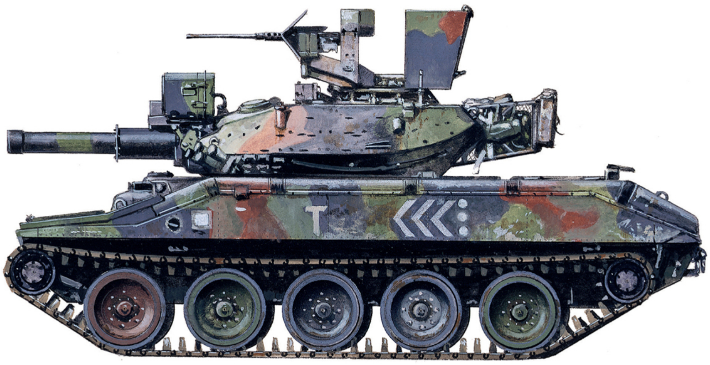
OPFOR WARRIOR

There were so many Sheridans sitting idle at Anniston Depot that 3/73rd Armor considered the idea of developing a paratroop fighting vehicle based on a turret-less Sheridan. This was intended as an airborne equivalent of the Bradley Infantry/Cavalry Fighting Vehicle or the Soviet BMD airborne vehicle. Several prototypes were locally constructed at Fort Bragg and armed with a 25mm Bushmaster cannon or a TOW anti-tank missile launcher. Although used on an experimental basis in the mid-1980s, this program was never formally accepted by the Army. A Soviet-style mechanized airborne force has never been considered seriously by the US Army due to doubts that enough air transport would be available.

The most extensive use of the Sheridan after the 1979 retirement was the allotment of 330 vehicles to the Army's National Training Center at Fort Irwin in California's Mojave Desert. These were rebuilt as VISMODs (visual modifications) to simulate standard Soviet AFVs, such as the T-80, BMP, 2S1, and ZSU-23-4, and were officially designated as the M551A2 opposing force vehicle. They were deployed with the "60th Guards Motor Rifle Division of the Krasnovian Army," the principal opposing force unit for force-on-force wargames and training. The vehicles were armed only with laser simulators and blank firing devices. These were the longest-serving Sheridans in the US Army, not retired until 2004.



The M551 Sheridan continued to soldier on in a training role at the National Training Center in the Mojave Desert. They were rebuilt as VISMODs (visual modifications) to represent Soviet tanks, and they served with the OPFOR (opposing forces). (Author)



M551A1, 3/73rd Armor, Panama, 1989. (Artwork by Tony Bryan © Osprey Publishing)

TANK ACTION IN LATIN AMERICA

The first operational use of the Sheridan since Vietnam was conducted during Operation *Just Cause* in Panama in December 1989, the only combat parachute drop of tanks in history. The political crisis was long in brewing, and a platoon of four M551A1 Sheridan tanks from 3/73rd Armor was flown into Panama in November 1989 and left hidden in a hangar at Howard Air Force Base, with its troops in mufti wearing 5th Infantry Division patches since they regularly conducted jungle training in Panama. Sheridan support was deemed vital, as the Panama Defense Forces operated a number of light armored vehicles.

Operation *Just Cause* was intended to overthrow the regime of Manuel Noriega by the surprise use of overwhelming force to minimize damage and bloodshed. A reaction brigade of the 82nd Airborne Division was inserted by parachute at Tocumen airport in the pre-dawn darkness of December 20, 1989, and included ten Sheridans of Co. C, 3/73rd Armor, which were parachuted from C-141B transports rather than air-landed. Two of these came to grief after landing in a marsh covered with elephant grass, with one being destroyed when its chutes failed to deploy and another damaged; the tankers parachuted separately from the tanks. The Sheridans helped to lead paratrooper columns to their objectives, blasting Panamanian roadblocks with their massive 152mm rounds. The Sheridans already in Panama were moved to Quarry Heights near the Panama Defense Forces' "La Comandancia" headquarters and took part in the final fighting to overcome the Panama Defense Forces. Maj. Frank Sherman, who led the Sheridans in Panama, concluded that "the M551A1 Sheridans of the Army's parachute tank battalion continue to offer the commander the decisive edge." The after-action report noted, "The presence of Sheridans raised the morale of friendly forces and Panamanian civilians. They had an extreme psychological effect on enemy forces and looters. Once Sheridans moved into an area or after an initial engagement involving the M551A1s, enemy forces generally refused to fire or snipe at convoys or positions in the vicinity of the Sheridans."

US tank production, 1960–75

	M48A5	M60	M60A1	M60A2	AVLB	M728	M551	Total
1960		420						420
1961		910						910
1962		875	145					1,020
1963			720					720
1964			585		56			641
1965			306		113	20		439
1966			288		4	68	28	388
1967			126		31	30	471	658
1968			170	(300)**	30	28	440	668
1969			175			17	361	553
1970			252		18	12	362	644
1971			278		48	30		356
1972			346		69	38		453
1973			140	268	4			412
1974			344	277				621
1975	108		651	31				790
Total	108*	2,205	4,526	576*	373	243	1,662	9,693

*Retrofit **300 M60A2 built but not accepted in 1968

Comparative technical data of US and Soviet tank guns, 1970

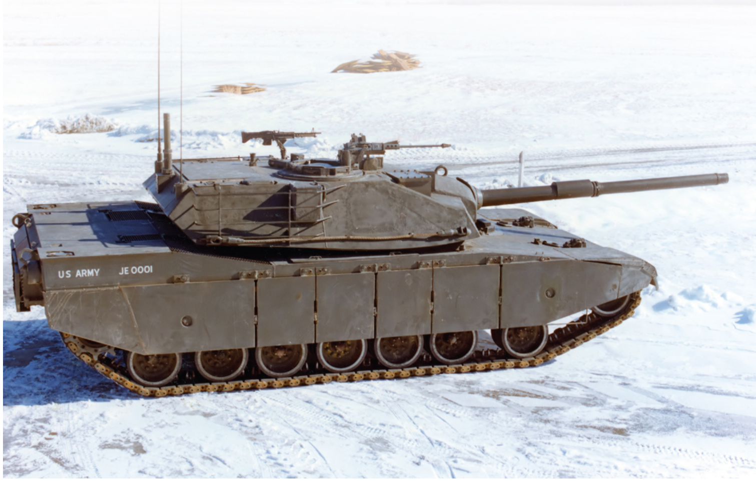
Caliber	105mm	105mm	115mm	125mm	152mm
Country	USA	USA	USSR	USSR	USA
Designation	M68	M68	U5-T	D81-T	M81
Length	L/54	L/54	L/53	L/51	L/16
Type	rifled	rifled	smooth	smooth	smooth
Ammunition	APFSDS	HEAT	APFSDS	APFSDS	ATGM
Designation	M735	M456	BM4	BM9	MGM-51
Muzzle velocity (m/s)	1,500	1,170	1,615	1,800	320
Projectile weight (kg)	4.65	10.2	5.34	6.5	26.8
Pen. in mm at 30° @2,000m	120	220	110	150	200

THE M1 ABRAMS

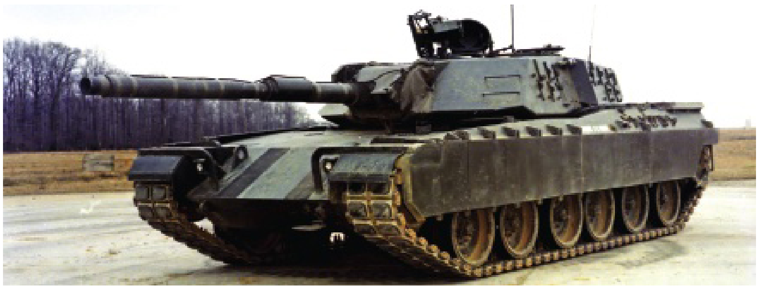
In the wake of the failed MBT-70 and XM803 tank programs, in January 1972 the Army immediately set out on a new effort, originally called the XM815 New Main Battle Tank (NMBT). The MBT Task Force, under Maj. Gen. William Desobry, concluded that a new tank was needed due to deficiencies in the M60A1 tank compared to contemporary Soviet tanks. The M60A1 suffered from an excessive silhouette, inadequate acceleration and cross-country speed, unacceptable reliability of the powertrain and armament system, lack of adequate firepower on the move, and insufficient ballistic protection against modern APFSDS projectiles. The program was quickly renamed as the XM1 tank to signal a new start.

The Office of the Secretary of Defense (OSD) approved the birth of the XM1 program in January 1973 with a stern warning about price constraints. The hardware cost objective was put at $507,790 (FY72) for a production run of 3,312 tanks. By way of comparison, the M60A1 tank cost $339,000 at the time, and the failed XM803/MBT-70 cost

$850,000 to $1,000,000. One of the main cost differences between the XM1 and M60A1 was the use of a thermal imaging night sight on the XM1, which amounted to nearly a quarter of the tank's cost. The program configuration was a competitive design effort with Ford, General Motors, and Chrysler receiving Army requests. Eventually, Ford decided against joining the program, and two development contracts were awarded to General Motors and Chrysler in June 1973.



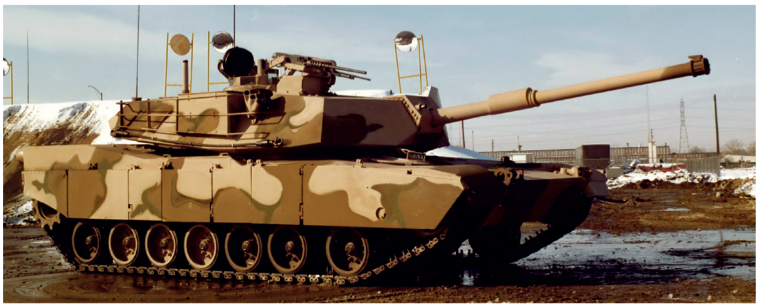
This is the original Chrysler XM1 validation phase pilot prior to the incorporation of the Burlington armor on the turret. It had numerous other differences, including the use of an M60D 7.62mm machine gun for the loader and an M85 .50-cal heavy machine gun for the commander. (US Army)



The General Motors contender for the XM1 program was very similar in overall configuration to its Chrysler competitor but was powered by a diesel rather than gas-turbine engine.

Propulsion for the XM1 was one of its most controversial features. The Army had sponsored the development of a tank gas-turbine engine in the 1960s, the AVCO-Lycoming AGT-1500. It was first considered for the MBT-70 in place of more conventional diesel engines. The Army's enthusiasm for the gas-turbine option was the result of the revolutionary improvement in Army helicopter propulsion due to gas turbines. Gas turbines are a form of jet engine, but with the power output through a transmission rather than jet exhaust. Compared to contemporary piston engines in terms of size and weight, the gas turbines were significantly smaller and lighter. In helicopter use, their simplicity led to lower maintenance demands and greater reliability.

There were some notable challenges in adapting gas turbines to tanks, especially their voracious consumption of fuel and air. Unlike conventional piston engines, which can be slowed to idle to conserve fuel when the tank is not moving, the gas turbine operates near peak power all the time, consuming fuel. In addition, the engine requires a substantial flow of air, which is a more significant problem in a land-combat environment than on helicopters due to the continuous presence of dust which can erode engine parts. In the end, Chrysler selected the more controversial turbine for its XM1 design, while General Motors stuck with an AVCR-1360 diesel. Although both engines were rated at 1,500hp, the actual power available from the turbine was greater, since only about 30hp had to be expended for engine cooling while the diesel required about 160hp for cooling.



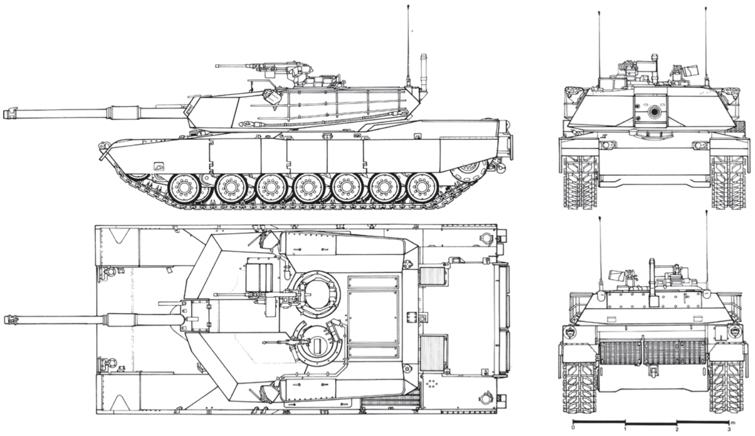
The XM1 Full Scale Engineering Development Pilot Vehicle #1 is seen here at the Detroit Army Tank Plant in February 1978. Some of the pilot tanks and low-rate initial production tanks carried the MERDC four-color camouflage as seen here. (US Army)

Several armament options were considered for the XM1, including the existing M68 105mm gun, a British 110mm gun, and the German Rheinmetall 120mm gun. Besides these basic options, there was consideration given to a next-generation guided 105mm projectile called Swifty, as well as the possible use of a co-axial 25mm Bushmaster automatic cannon to deal with the threat of light armored fighting vehicles. Although the Tripartite Gun Trials by Germany, the UK, and the USA in 1975 concluded that the German 120mm gun was the best-suited to meet the long-term threat, in January 1976, OSD approved the Army decision to stick with the 105mm gun in the initial production series of the XM1, since the baseline threat was considered to be the Soviet T-62 tank. At the time, the US Army was vaguely aware of the new Soviet T-64, dubbed the M-1970, and unaware of the T-72 tank.

The XM1 requirements called for armor protection against the Soviet T-62 tank's 115mm APFSDS projectile at 800–1,200 meters and the AT-3 Sagger missile's 127mm HEAT warhead over a 50-degree frontal arc. Side protection was sufficient to defeat the RPG-7 rocket launcher at 45 degrees on the crew compartment sides and at all angles against the turret side. The initial designs of the XM1 used conventional steel armor.

Since 1964, the British Army's Fighting Vehicles Research and Development Establishment (FVRDE) at Chobham had kept the US Army informed about its research on Burlington "special armor." This was an armor package consisting of modules with spaced laminates of steel and other materials fitted over conventional welded steel armor. Burlington offered superior performance to steel armor in the defeat of shaped-charge HEAT warheads, while at the same time being equivalent to conventional steel armor in defeating APFSDS kinetic-energy penetrators. The UK and the US began discussions on a memorandum of understanding about the development and use of Burlington armor in 1969, but plans to incorporate it into the XM1 design do not appear to have begun until 1973, after the start of the program.

The M1 Abrams main battle tank was first deployed in significant numbers in 1982. One of the first units equipped was the 2nd Armored Division at Fort Hood, Texas. These are from 3/67th Armor. (Author)

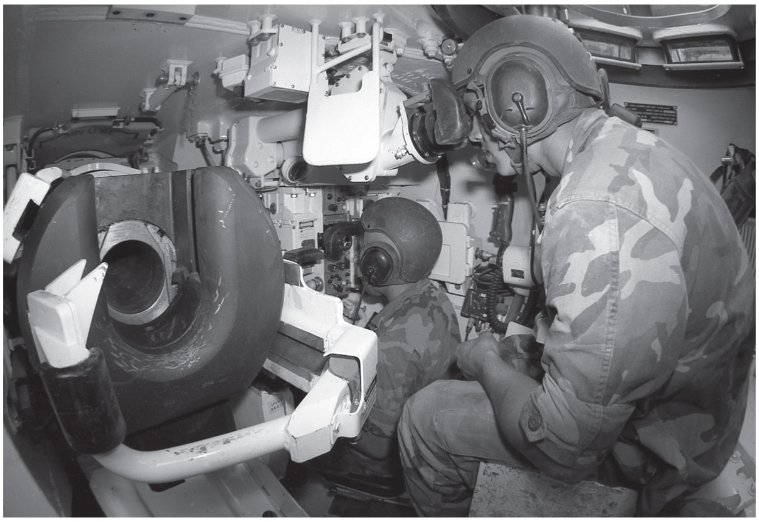


M1 105mm tank. (Author)

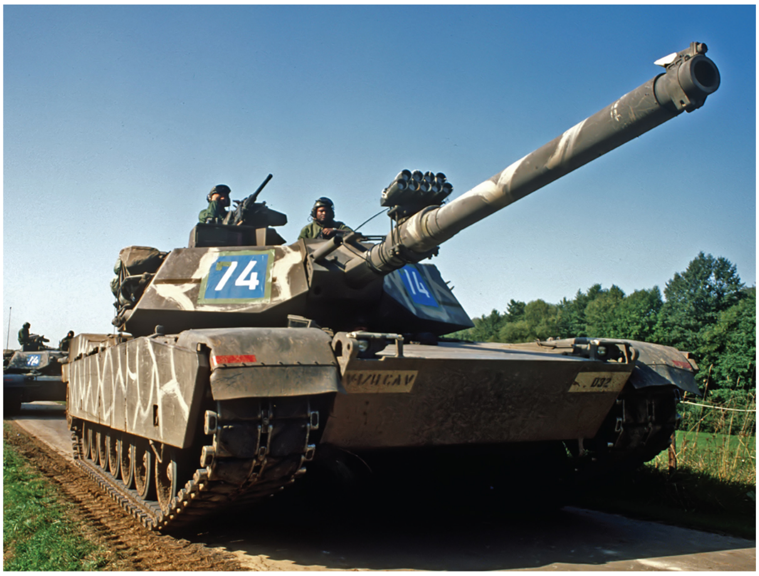
A major incentive for adopting Burlington armor was the Israeli combat experience in the 1973 Yom Kippur War. The Israeli tank force suffered heavy losses at the hands of RPG-7 anti-tank rocket launchers and AT-3 Sagger (9M14M Malyutka) anti-tank missiles. The initial pilots of the XM1 program during the validation phase had conventional steel armor, but the turrets and hull were redesigned to incorporate an improved version of Burlington armor developed in conjunction between the FVRDE and the Ballistics Research Lab (BRL) at Aberdeen Proving Ground in Maryland under the codename "Green Grape."

Besides the armor package, the XM1 designs began to explore other methods to protect the crew. The primary source of catastrophic tank loss in combat is the ignition of main gun ammunition propellant. To minimize the hazard posed by the ammunition, tank designers since World War II advocated transferring the ammunition to the floor of the tank where it was least likely to be hit. This configuration is no guarantee that the ammunition will not be hit, since mine damage or ricocheting projectile fragments inside the tank can set it on fire. Furthermore, the floor location is difficult for loaders to reach, especially in view of the growing weight and size of modern tank ammunition. The US Army began to explore the idea of encapsulating the ammunition in a bustle at the rear of the turret. The ammunition compartment could be separated from the fighting compartment by sliding blast doors and open only for a short time when the loader extracts a round. Should the ammunition be set afire, the blast doors would protect the crew long enough to escape, and in many cases would slow or prevent the spread of a catastrophic fire into the rest of the tank.

The developmental and operational trials of the validation phase pilot tanks were conducted at Aberdeen Proving Ground in January–May 1976. In the meantime, the OSD acceded to a German request to consider joint production of the new Leopard II tank. The Leopard IIAV (American variant) underwent trials at Aberdeen Proving Ground in the autumn of 1976. The Leopard II was judged to have superior fire controls, but inferior armor, ammunition compartmentalization, and gun traverse. The main problem was cost. FMC Corporation teamed with Krauss-Maffei in Germany to build the Leopard IIAV at their San Jose plant should it be selected by the US Army. FMC conducted a study for the US Army that concluded that the Leopard IIAV would cost 25 percent more than either of the XM1 pilots to manufacture in the United States. As a result, the Leopard IIAV was withdrawn from consideration. Both governments agreed to consider using common components, including the American AGT-1500 turbine engine and the German 120mm gun.



A view inside the turret of an M1 Abrams, with the gunner in the front and the tank commander behind him and the 105mm gun breech in the foreground. (Author)



An M1 Abrams of the 11th Cavalry taking part in the Reforger '83 maneuvers in Germany as part of Force Blue. This tank is fitted with the MILES laser training system, including the gunfire simulator over the gun barrel and the laser detector strip around the turret. (US Army)

The first set of trials led the US Army to favor the General Motors design, but the performance of the AGT-1500 was favorable enough that the Army considered incorporating the AGT-1500 into the General Motors pilot. OSD insisted that both General Motors and Chrysler redesign their turrets to potentially accommodate the German 120mm gun. The Chrysler team, under Dr. Phillip Lett, used this opportunity to substantially redesign the turret to incorporate the Green Grape armor, and to make a number of fire control upgrades. At the same time, other changes were made to drive down unit cost, a major criterion in the OSD evaluations.

In the event, the modified Chrysler design was selected on November 12, 1976, to proceed to full-scale engineering-manufacturing development (FSED). The FSED phase involved the construction of 11 pilot tanks, the first of which was delivered in February 1978. In August 1976, the Army selected the Lima Army Tank Plant (LATP) as the primary production facility, with the Detroit Army Tank Plant (DATP) as the secondary source. In July 1977, the production objective for the XM1 was increased to 7,058 tanks.

Trials of the XM1 pilot tanks were satisfactory enough that a limited-rate-initial-production (LRIP) contract was awarded on May 7, 1979, for the first 110 LRIP tanks, funded in the FY79 budget. The first production tank was delivered by Lima in February 1980, and the tank was type classified as the M1 tank in February 1981. It was named after Creighton Abrams, the Army Chief of Staff during the later part of the Vietnam War, and a World War II tanker. Abrams had been instrumental in pushing along the XM1 program, despite many political and budget hurdles, but had died at an early age in 1974 before the program reached completion.

Chrysler Defense was sold to General Dynamics in March 1982, becoming the General Dynamics Land Systems division (GDLS). The LRIP tanks were issued to the 2/5th Cavalry at Fort Hood, Texas, for the third and final set of operational trials, and they were also used for a variety of extreme weather tests. The first tanks from the Detroit plant were delivered in March 1982. By the summer of 1982, 585 tanks had been delivered, all trials had been completed, and five battalions of M1 tanks deployed – three in Europe and two in the US. The last baseline M1 was completed in January 1985.

Alongside the development of the XM1 tank, there was a parallel effort to develop improved tank ammunition for its M68A1 gun. The APFSDS projectile, using a depleted uranium penetrator, the 105mm

M774, entered service in the summer of 1981, followed by the improved M833 in the autumn of 1983. There was also a new 105mm HEAT round, the M815, that entered service in the spring of 1987.

US tank inventory, March 1983

	Active Army	Reserves	National Guard	Marine Corps	Total
M48A5	357	29	1,317	0	1,703
M60	202	102	1,165	0	1,469
M60A1	159	21	67	646	893
M60A1(AOS)	739	0	30	0	769
M60A1 (RISE)	516	0	37	0	553
M60A1(RISE/ Passive)	2,055	0	0	0	2,055
M60A2	540*	0	0	0	540
M60A3 (Passive)	138	0	138	0	276
M60A3 (TTS)	2,483	0	186	0	2,669
M1	977	0	63	0	1,040
M551	54	0	0	0	54
Total	8,220	152	3,003	646	12,021

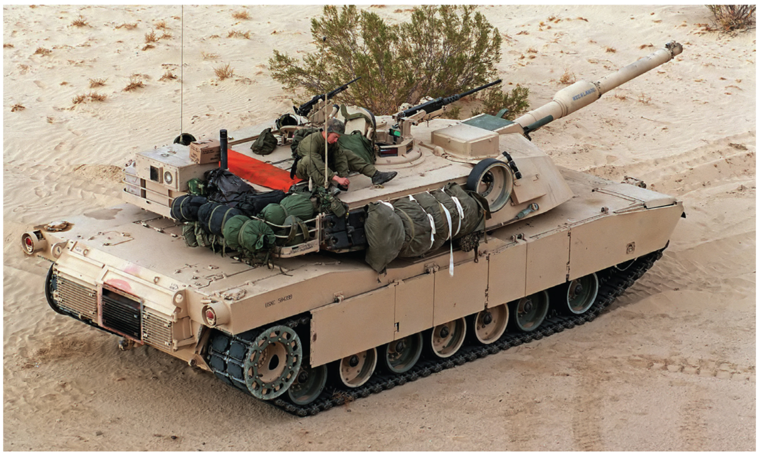
*In storage

THE M1A1 ABRAMS MBT

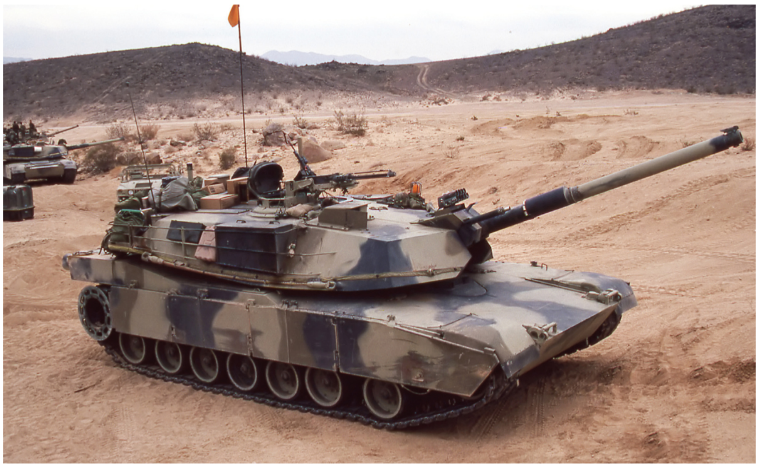
By the time the M1 tank was approaching production, the US Army finally appreciated that the Soviet tank threat had changed due to the advent of the newer T-64 and T-72 tanks, armed with a 125mm gun. Although precise details of Soviet tank armor were not known at the time, there was the presumption that the Soviet Union would adopt some form of special armor that could resist the 105mm gun. On January 31, 1978, the US Army approved the adoption of the German

Rheinmetall 120mm smooth-bore gun on a future production version of the M1 tank. This decision led to the start of the M1E1 Block 1 program in June 1979. The German gun was simplified and adapted to American manufacturing techniques at the Watervliet Arsenal in New York and the first example of the XM256 120mm gun delivered in April 1980.

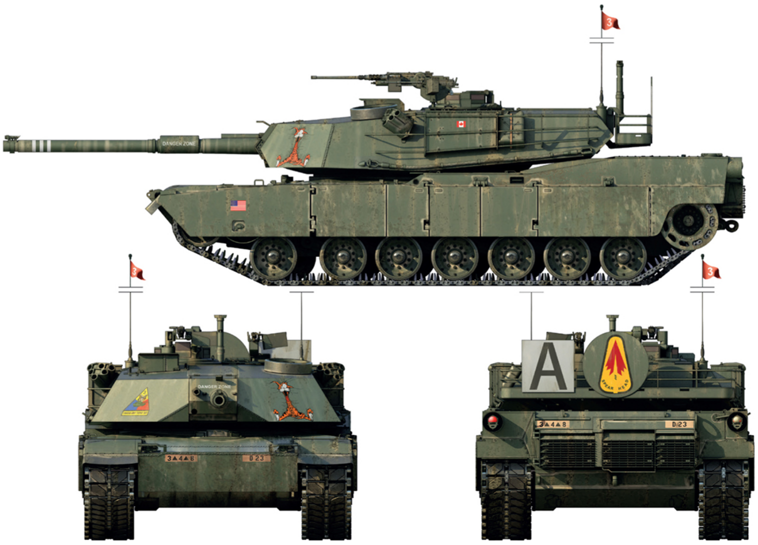
Besides the new gun, a variety of other improvements were being developed as part of a "Block" upgrade effort. This included a new generation of special armor to deal with the Soviet 125mm tank gun, a hybrid NBC (nuclear, biological, chemical) protective system, a micro-cooling vest for operations in hot weather, and a variety of suspension, transmission, and final drive upgrades. The first M1E1 pilots were delivered in March 1981. Details of the upgraded armor package remain secret, but a Soviet report assessed the armor protection of the M1A1 against APFSDS to be equivalent to 600mm RHA (rolled homogenous armor) compared to 470mm for the M1, and 700mm against HEAT, compared to 650mm for the basic M1.



An M1A1 tank of the 2nd Tank Battalion, 2nd Marine at the Air Ground Combat Center, 29 Palms, California, on February 1, 2000. A large portion of the Abrams fleet received External Auxiliary Power Units (EAPUs) fitted in the left of the turret bustle rack as seen here. (US Marine Corps/Pfc. Andrew A. Thornton)

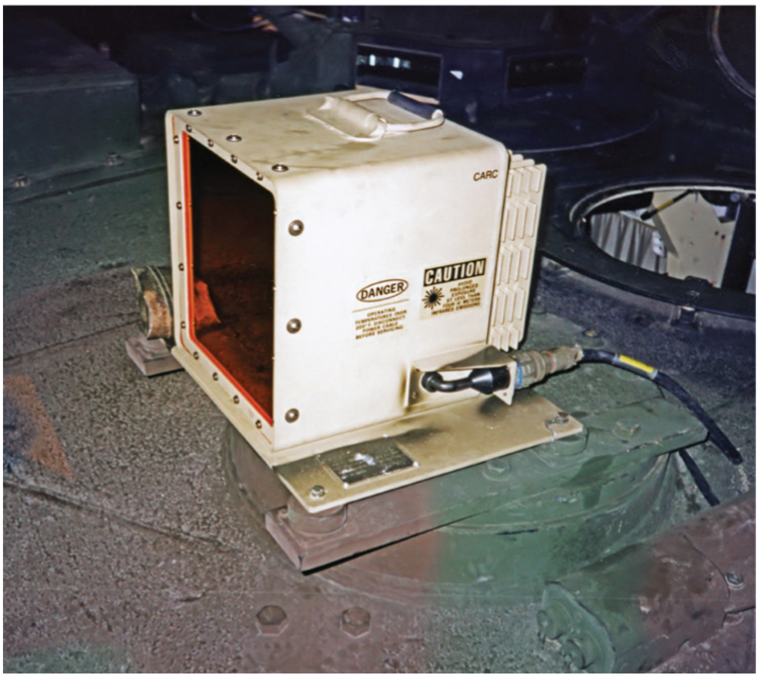


The IPM1 introduced some of the features developed for the M1A1, including the better armor package, but retained the 105mm gun. This IPM1 is seen here at the National Training Center at Fort Irwin, California, in the Mojave Desert in a locally applied camouflage scheme. (Author)



M1 IP, 4/8th Cavalry, Germany 1987. (Artwork by Felipe Rodríguez © Osprey Publishing)

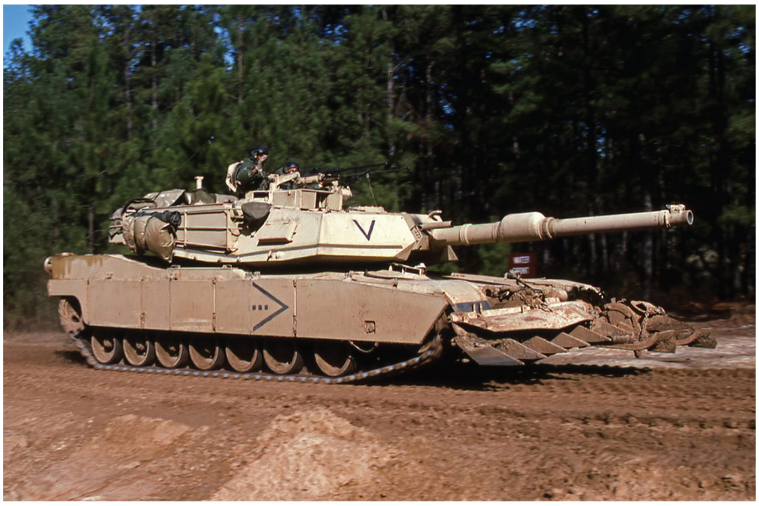
The Block improvements on the M1E1 were readily adaptable to the production line, and so the Army decided to manufacture the final series of M1 in an improved production IPM1 configuration. A total of 2,374 basic M1 tanks were manufactured through January 1985, and the IPM1 entered production in October 1984, with 894 manufactured through May 1985. The IPM1 included all of the upgrades envisioned on the M1E1 except for the 120mm gun and NBC suite. The first IPM1 tanks were deployed with Co. C, 2/69th Armor, at Fort Benning in early 1984. The IPM1 was subsequently renamed as the M1 IP.



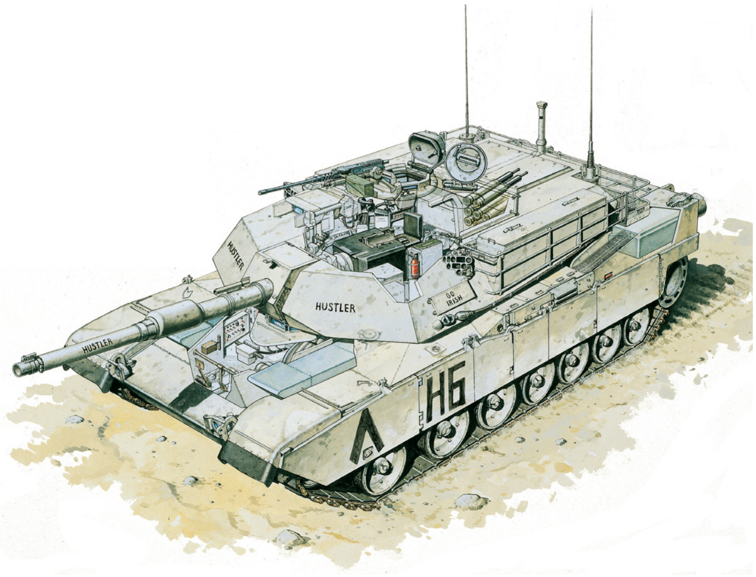
The US Army developed a Missile Countermeasure Device (MCD) as a soft-kill protection system against anti-tank missiles using electro-optical jamming. This is a Loral AN/VLQ-6 fitted on a Marine M1A1. The similar Sanders AN/VLQ-8A MCD was acquired at the same time as an urgent requirement prior to Operation *Desert Storm*. They were usually mounted on the circular CITV plate in front of the loader. (Author)

Consideration was given to the adoption of a Commander's Independent Thermal Viewer (CITV) on the M1E1. The tank commander on the baseline M1 tank could view the thermal images captured by the gunner's sight via an optical elbow, but the CITV would have provided an independent sight that the commander could employ to hunt for targets. Although this "hunter-killer" concept was strongly favored, thermal sights during this period were very expensive. As a result, the CITV was not incorporated on the M1E1, although a circular roof opening was added to the design so that a CITV could be easily added at some future point.

Another upgrade under study at the time was an auxiliary power unit (APU). The APU was desired since the electrical demands of the fire control system and other vehicle electronics would quickly drain the tank batteries when the engine was not running. As a result, the turbine engine had to be used to keep the electronics powered even when the tank was stationary. Unlike a conventional engine, a turbine operates near peak power at all times, and this was inefficient when the tank was stationary, consuming about 10 gallons of fuel per hour. A variety of diesel and gasoline-powered APUs were examined, including bustle-mounted gasoline and diesel APUs, and a diesel APU fitted to the left rear of the hull. However, the APU was not incorporated as a standard fitting at the time, mainly for cost reasons. However, this issue would crop up again once the Abrams saw extensive combat service. Some APUs were deployed on Abrams tanks during Operation *Desert Storm*.



Priority for the new M1A1 Abrams went to USAREUR, which began receiving them in large numbers by 1988. They saw their combat debut in 1991 during Operation *Desert Storm*. This is an M1A1 tank fitted with a Track Width Mine Plow of the 24th Infantry Division (Mechanized) at Fort Stewart, Georgia, shortly after its return from the Gulf War in 1991. (Author)



M1A1HA Abrams, Operation *Desert Storm*, 1991. (Artwork by Peter Sarson © Osprey Publishing)

The M1E1 was type classified as the 120mm gun tank M1A1 in December 1984, and the first production tanks were delivered in August 1985. Priority for the new version went to USAREUR, which began receiving them in large numbers by 1988. Further evolution of special armor continued, including a configuration using depleted uranium – metallic uranium consisting of isotopes emitting little or no radiation. The principal advantage of uranium is its weight and density, about double that of lead per volume. Depleted uranium was employed in the third generation of special armor on the M1A1, leading to a variant dubbed the M1A1HA (Heavy Armor). Besides being incorporated into new production tanks starting in October 1988, the heavy armor package could also be retrofitted to existing M1 IP and M1A1 tanks. The M1A1 and M1A1HA were the principal types of Abrams used in the 1991 war with Iraq.

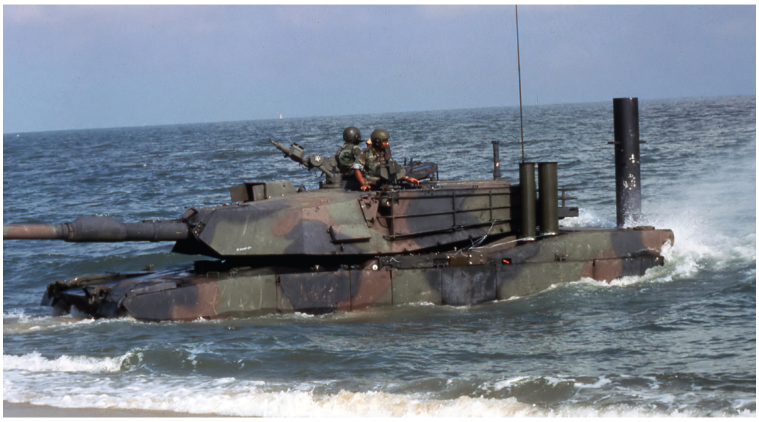
The US Marine Corps decided to adopt the M1A1 as its next main battle tank. Some modifications were necessary, most notably adaptations to permit the attachment of Deep Water Fording Kits (DWFKs) to permit the tanks to be landed offshore from landing craft. These adaptors did not materially affect the tank in any way and were not particularly expensive. As a result, the Army decided to incorporate these features on the production line for both Army and Marine tanks. The resulting variant was sometimes called the M1A1 CT (Common Tank); Marine tanks with the heavy armor package were dubbed M1A1 Heavy Common. Marine Corps procurement was funded in FY90–91 with a total of 215 tanks. This number later increased to 445 tanks due to transfers from the US Army.

Total US M1A1 production, including the US Army procurement, 58 M1A1 tanks funded by the National Guard, and 215 M1A1 Common Tanks funded by the US Marine Corps, totaled 4,771 tanks. Some reports list other totals depending on whether pilots and pre-production test vehicles are included. The last new-production M1A1 was delivered on April 28, 1993. Combined with the 62 M1A2 tanks described, this brought total US Abrams production to 8,101 tanks. Production of new tanks for export continued through 2000, reaching a total of 9,748 Abrams tanks, of which 6,306 were produced at Lima and 3,442 at Detroit.

Comparative technical data of Abrams tanks

Designation	M1	M1A1	M1A2	M1A2 SEPv2
Crew	4	4	4	4
Loaded weight (tons)	60.0	67.5	68.4	71.2
Length overall (in)	387	387	387	387
Width (in)	144	144	144	144
Height (in)	140	140	140	140
Protection vs. HEAT (mm)*	650	700 (HA:900)	1300	1500
Protection vs. APFSDS (mm)*	340	380 (HA:700)	700	950
Main gun type	M68A1	M256	M256	M256
Gun caliber (mm)	105	120	120	120
Elevation (degrees)	-10 +20	-10 +20	-10 +20	-10 +20
Rounds stowed	55	40	42	42
Co-axial MG	7.62	7.62	7.62	7.62

Engine	AGT-1500	AGT-1500	AGT-1500	AGT-1500
Engine type	Gas-turbine	Gas-turbine	Gas-turbine	Gas-turbine
Horsepower	1,500	1,500	1,500	1,500
Transmission	X-1100-3B	X-1100-3B	X-1100-3B	X-1100-3B
Road speed (mph)	45	41	41	42
Max. range (mi)	275	298	298	298
Fuel (gal)	495	495	495	495
*Estimated equivalent of rolled homogenous armor to direct frontal attack				

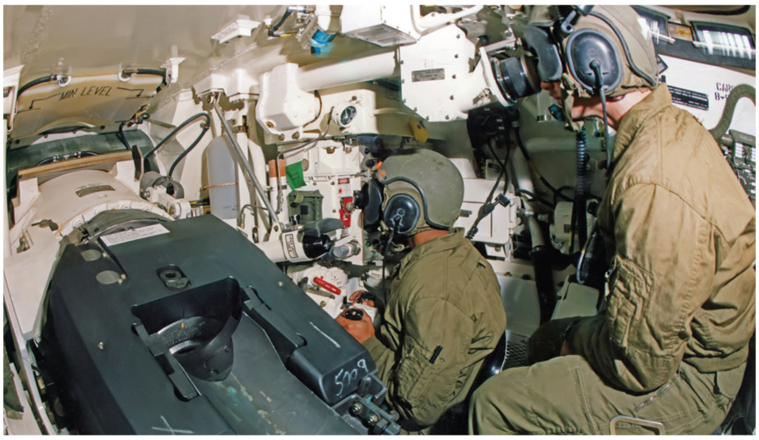


The Marine Corps requirement for adaptors to attach the Deep Water Fording Kit led to the M1A1 Common Tank, which was manufactured at the tail end of M1A1 production for both the US Army and Marine Corps. (Author)

M1A1 TANK CREW

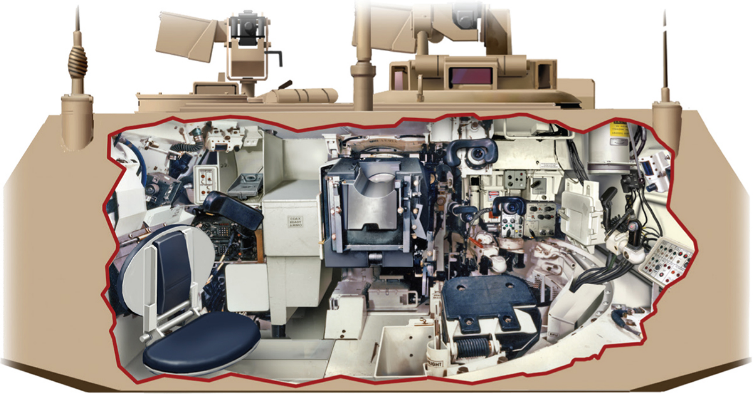
The M1A1 had a crew of four: tank commander, gunner, loader, and driver; all were stationed in the turret except for the driver who was positioned in the center of the front hull. The three-man turret crew were located with the loader on the left and the gunner and tank commander on the right.

The tank commander (TC) was positioned behind the gunner on the right side of the tank. The tank commander was responsible for leading the tank in combat. In a platoon of four tanks, the platoon leader was a second lieutenant (O-1); the platoon sergeant was usually a sergeant first class (E-7) or staff sergeant (E-6); the two "wingman" tanks would also be commanded by sergeants. The TC was stationed below a rotating cupola and hatch, which provided all-around direct vision, when buttoned up, by means of direct-vision periscopes. The commander was also provided with an optical adjunct from the gunner's primary sight, and the commander could both aim the tank's weapon system and fire it if necessary by means of these override controls. The commander's hatch had three positions: fully open or fully closed, and an intermediate position where the hatch could be locked partially opened overhead to allow the TC to hear and see all around while at the same time offering some overhead cover. US Army training encouraged the tank commanders to ride with their heads outside the tank since this provided better situational awareness. The commander's station included a .50-cal heavy machine gun mounted in a remote-control mount. This weapon could be operated from inside the tank fully buttoned up, and a periscopic sight was provided to the commander for the function. The commander also had controls for activating the smoke grenade launchers on the front sides of the turret which were used to defend the tank.

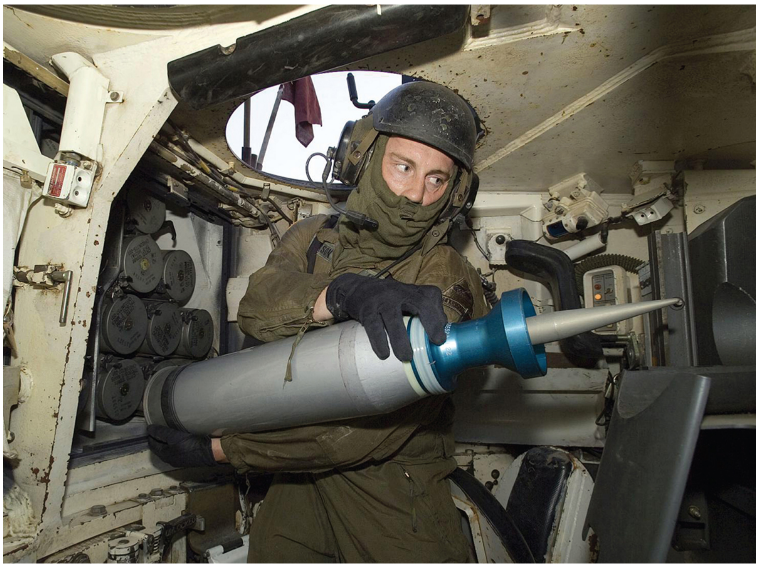


A view of the right side of the turret of the M1A1 Abrams with the 120mm gun breech in the foreground. The tank commander, seen here to the right, viewed the target via an optical adjunct to the gunner's primary sight. The gunner can be seen to the left in front of the tank commander. (GDLS)

Second in seniority in the tank crew was the gunner, a sergeant in rank. The gunner sat immediately in front of the commander on the right side of the main gun. The gunner's primary sight was located immediately in front of him and consisted of an integrated day/night-sighting system with laser rangefinder and a digital ballistic computer. The M1A1 fire controls were designed to be as automated as possible to permit the gunner to concentrate on his main task of acquiring the target identified by the commander, and accurately aiming the tank's weapons. The gunner's inputs included selecting whether to engage the target with the main gun or the co-axial machine gun, identifying the main gun ammunition type to ensure the proper offsets by the ballistic computer. The gunner's gun controls were operated using palm switches on the "Cadillac" grips, which allowed the gunner to turn the turret right or left, elevate or depress the main gun, and trigger the main gun or co-axial machine gun. The "Cadillac" nickname came from the manufacturer, Cadillac Gage.



M1A1 turret interior. (Artwork by Jim Laurier © Osprey Publishing)



The main ammunition stowage in the M1A1 Abrams is in the bustle behind two sliding blast doors. This view of a loader in action shows the left door still in the open position. The loader is handling an M865 120mm TPCSDS-T (target practice, core stabilized, discarding sabot-tracer), used to simulate the M829A1 combat round during training. (US Army)

The loader was usually the lowest in seniority in the turret crew and was positioned in the left side of the turret. The loader armed the main gun on the instructions of the tank commander, and he had to be quite strong and agile as the rounds weighed over 65 pounds each. The main ammunition stowage was located in the turret bustle behind blast doors, with two 16-round racks on either side of the turret and one or two two-round-ready racks at the extremities. There was an additional three-round-ready rack in front of the loader in the left hull. Access to the main ammunition reserve in the left rear bustle was by means of a blast door that was actuated by the gunner using a knee switch, which allowed him to keep his hands free during the loading process. The loader's hatch was fitted with an M240 7.62mm machine gun for close-in defense of the tank. The tank radio was located in front of the loader's station.

The driver was isolated from the rest of the crew in the forward hull. The M1A1 driver's station was a considerable change from earlier US tank designs, and instead of a conventional seat, the driver lay on his back in a semi-prone position. The seat was adjustable and could be raised to a more vertical position when the driver was operating with his head outside the hatch, and a more prone position when driving buttoned up. The driver's main controls were a steering yoke, which operated much like motorcycle handlebars.

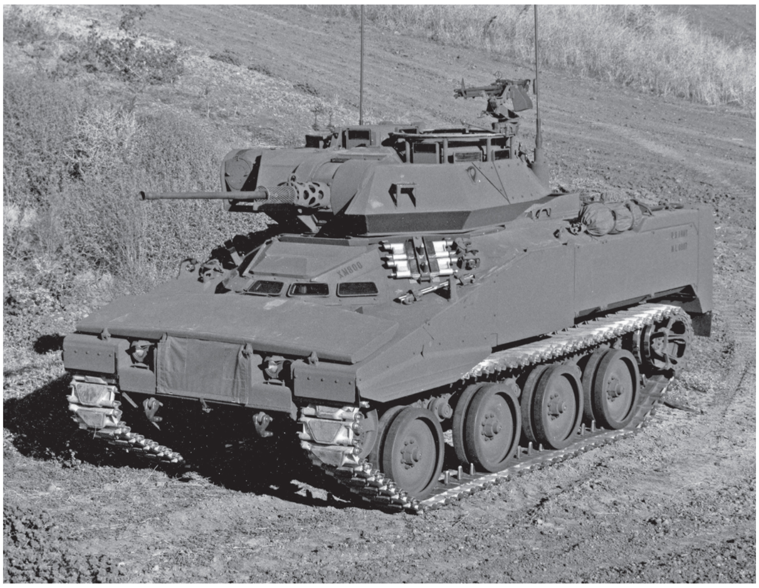
US TANK CREW TRAINING POST-VIETNAM

The US Army had undergone a renaissance in the 1980s after the hollow years of the 1970s. During the Reagan years, the Army had finally shaken off the legacy of the Vietnam War, and many young officers who had been platoon, company, or battalion commanders in Vietnam had become senior Army leaders in the 1980s and were ardently intent on reform. The intellectual ferment within the officer corps culminated in the "AirLand Battle" doctrine and greater emphasis on "train as you fight." At the same time, the increased defense funding of the 1980s permitted both a rejuvenation of equipment, such as the adoption of the M1 Abrams tank and M2 Bradley Infantry Fighting Vehicle, as well as a substantial increase in operations and maintenance funding, which permitted more training and better-quality training. The shift from the Vietnam War's draftee army to a professional army was an important element in raising the motivation and skills of the soldiers.

US tanker training has traditionally centered around Fort Knox, Kentucky, the home of the Armor School since World War II. After basic training, US Army tankers were sent to Fort Knox for their specialist training. Young second lieutenants were sent to the Armor Officer Advance Course. The 1980s saw the beginning of a technical revolution in training. In the past, training on maintenance-intensive weapons such as tanks was invariably limited by budget, since training leads to considerable wear and tear on the equipment, and training ammunition is expensive. The advent of the M1 Abrams was accompanied by the advent of computer-based training simulators. These were not an adequate substitute for hands-on training with real equipment but were an invaluable supplement to traditional technical-skills training since they allowed the new tankers to repeatedly rehearse basic combat skills more often at a far more modest cost. The computer-based tank simulators at Fort Knox also allowed elementary small-unit training, since the individual "tanks" could be netted together by computer to conduct missions.

Once through their specialist training, tankers were dispatched to their units, where training continued. The US Army fostered a system of continuing training within the unit. Fort Knox also served as the venue for continued career training with the Advanced NCO (non-commissioned officer) Course and the Armor Officer Advanced Course. The growing technical proficiency of US tankers became evident in tangible ways. The NATO armies in Europe had traditionally held a Canadian Army Trophy (CAT) gunnery contest, and the US Army teams had not won the event for nearly two decades until an M1 Abrams team won in 1986. Once assigned to forward-deployed units in Germany, technical skills continued to be honed through training, such as the gunnery ranges at Grafenwöhr in Germany, and small-unit skills were improved at the Combat Maneuver Training Center at Hohenfels.

Technological innovations helped to add to the frequency and realism of small-unit tactical training, such as the introduction of laser simulation devices which made it possible to conduct more realistic tank-on-tank engagements during exercises. The culmination of this revolution in training was the refurbishment of the Army's Mojave Desert training center as the National Training Center (NTC). The NTC was computerized and fully instrumented to permit the recording of simulated battles so that a post-mortem could be conducted for "lessons learned." The NTC had its own highly trained opposing force (OPFOR) to ensure a constant and demanding test experience for visiting units. Rotation through the NTC encouraged units to practice and prepare in advance of their visit to the desert battleground, which further polished small-unit tactical skills. The increased funding of the 1980s was instrumental in this process, since it cost in the order of $10 million to rotate a brigade through the NTC. By 1990, the US Army was arguably the best-trained military in the world.



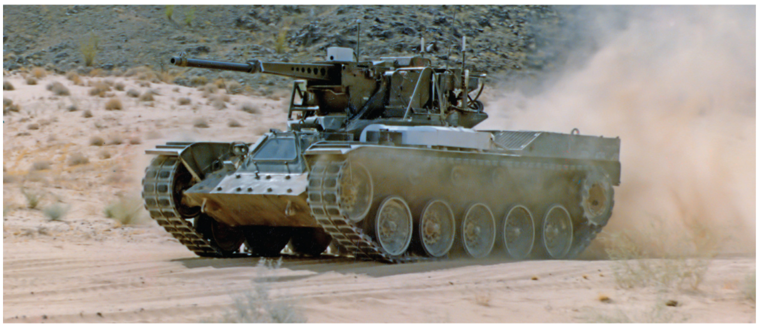
The XM800T ARSV was a short-lived attempt to replace the failed M114 Command and Reconnaissance Carrier. Although canceled in 1974, it bears some resemblance to its successor, the M3 Bradley Cavalry Fighting Vehicle, since the turrets of both were designed by FMC Corporation.

CAVALRY TANK

The equipment requirements for the US Army mechanized cavalry oscillated between very light scout vehicles to more substantial armored vehicles. The Army had adopted the M114 Command and Reconnaissance Carrier in the early 1960s, but it was widely viewed as a technical failure. Development of a successor began in 1971 as the XM800 Armored Reconnaissance Scout Vehicle. Two different vehicles were built to test different configurations. The Lockheed XM800W was an unconventional six-wheel, all-wheel drive, articulated chassis with an external automatic cannon. FMC Corporation offered a more conventional design, the XM800T, essentially a light tank with a 25mm Bushmaster cannon in the turret. In 1974, the Cavalry Scout Ad Hoc Committee concluded that a new scout vehicle was not warranted, and the program was terminated. Instead, the Army decided to meet the scout requirement with a variant of the new M2 Bradley Infantry Fighting Vehicle, the M3 Bradley Cavalry Scout Vehicle. Both types were accepted for service in 1979.

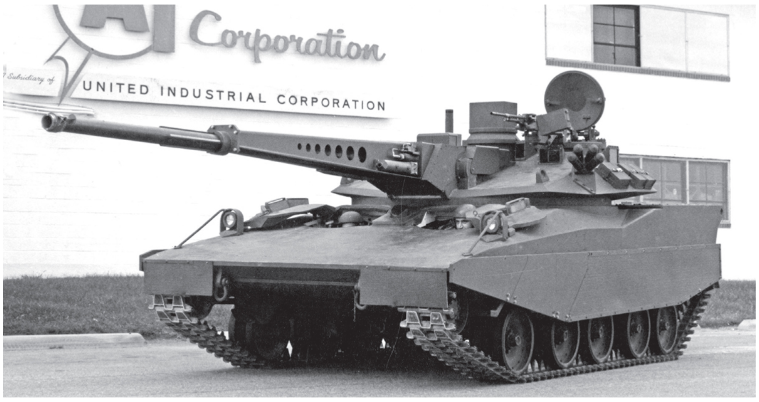
THE TEST-BED ERA

One of the lessons from the ill-fated MBT-70 program was that advanced tank subsystems were a frequent bottleneck in new tank designs unless the technology already was mature. In the late 1970s, TARADCOM (Tank-Automotive Research and Development Command, formerly OTAC) began the Armored Combat Vehicle Technology (ACVT) program to examine tank subsystems outside of a normal tank development effort. The first part of this effort was to construct several tank test beds to examine novel technologies to aid tank survivability and weapons configurations. These were intended to serve as the basis for at least six future vehicles: the Marine Corps' Mobile Protected Weapons System, an Army main battle tank replacement for cavalry units, an anti-tank cavalry vehicle, a replacement for the M901 Improved TOW Vehicle (ITV) on the M113 chassis, a new light tank for light divisions, and an infantry vehicle with anti-armor capability.

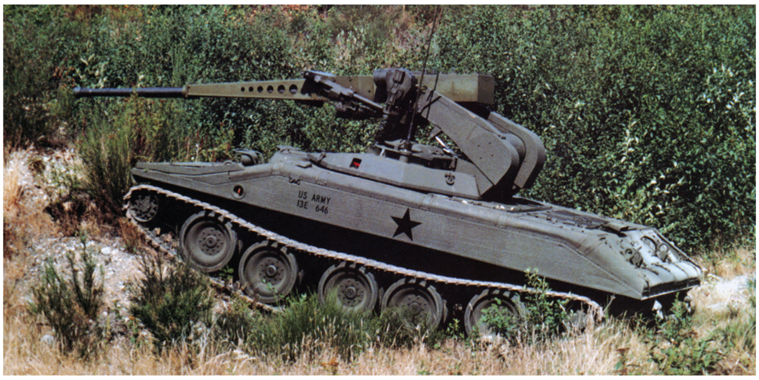


The HIMAG was a medium-weight test bed built by Pacific Car and Foundry to test a variety of suspension and powerplant options. It is seen here during trials at the Yuma Proving Ground in 1979.

The High-Mobility Agility Test Vehicle (HIMAG) and the High-Survivability Test Vehicle, Light (HSTV-L) were aimed at studying the advantages of high speed and maneuverability as it affected tank survivability. The HIMAG vehicle was a modular design that could accommodate many variations in engineering features, including vehicle weight, wheel travel, wheel-base, various engine types, different fire controls, and others. It was built by the National Water Lift Company and underwent factory tests at Fort Custer, Michigan, prior to delivery to Fort Knox in January 1978 for Army testing. The HIMAG was powered by a Continental AVCR-1360 diesel that could be tuned up from 1,000 to 1,500hp. The test bed used the Allison X-1100-1H transmission, Delco Electronics fire control system, and a hydro-pneumatic suspension. It was armed with a 75mm MC-AAAC hypervelocity smooth-bore gun on an elevated mount, with the commander and gunner sitting in the turret basket below it. The test bed was examined in configurations weighing from 32 to 45 tons. Final integration of the HIMAG chassis with the gun, turret, and fire control systems was completed in late 1979. HIMAG was used to test ride dynamics at high speed, advanced fire controls with fire-on-the-move capability, and other technologies. The HIMAG chassis was the program's first experience with a highly instrumented test bed, and there were severe dependability problems that plagued the testing. Field test data collected at Fort Knox through the end of tests in 1981 was fed into mobility and combat simulation models to determine what effect mobility and agility have on the survivability of tracked vehicles.



The High Survivability Test Vehicle, Light (HSTV-L) developed by AAI Corp., had a strong resemblance to its earlier light tank designs, notably the T92 from the 1950s. It was also a forerunner to later AAI Corp. expeditionary tank ideas such as the RDF light tank.

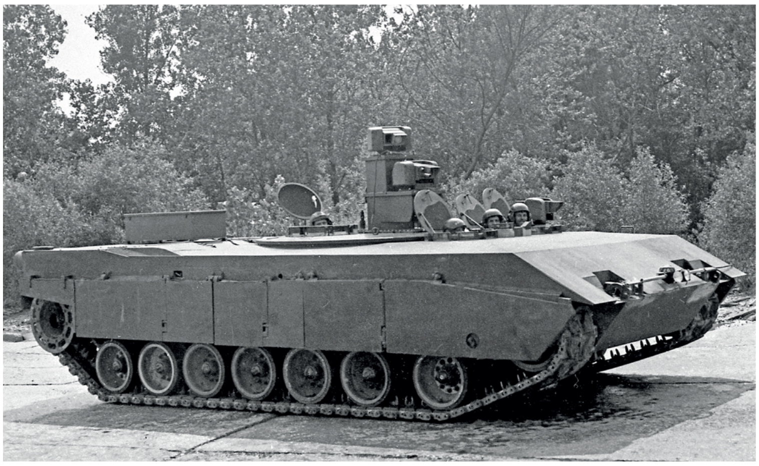


The Elevated Kinetic Energy (ELKE) was a test bed built by Pacific Car and Foundry to determine the feasibility of an elevated gun mounted for light tanks. This allowed a lightly armored tank to remain mostly under cover during an engagement.

After initial feasibility studies in 1977, AAI Corporation was selected to build the HSTV-L in 1978. AAI had built the T92 light tank in the late 1950s; the HSTV-L showed family resemblance with a rear-mounted, low-profile turret. The HSTV-L had a design weight of 19 tons and used an AVCO Model 800 gas-turbine engine with a Detroit Diesel cross-drive X-300-4A transmission to obtain high performance. Unlike the HIMAG, its design was closer to that of an actual light tank than an instrumented test bed. The HSTV-L was largely aimed at future light tank requirements, notably the Marine Corps Mobile Protected Weapon System and a possible light tank to replace the M551 Sheridan in the airborne divisions. It was equipped with a "hunter-killer" fire control system that allowed the vehicle to fire while on the move. It was armed with a novel Ares 75mm automatic cannon. Testing began at Aberdeen Proving Ground in March 1980, about three years after the HIMAG program, and concluded in 1981.

A third test bed was added in the early 1980s, constructed by Pacific Car and Foundry. The ELKE (Elevated Kinetic Energy test bed) used the hull of the M551 Sheridan fitted with an externally mounted Ares 75mm automatic cannon. The ELKE was used to determine the practicality of an elevated tank gun that could be fired from behind cover, allowing the tank hull to remain protected during an engagement. This was mainly intended for future light tanks to reduce their vulnerability. The ELKE 75mm elevated gun was first test fired in

April 1981 and the test bed completed in early 1982. It was sent to the Yuma Proving Ground for further testing in 1982.



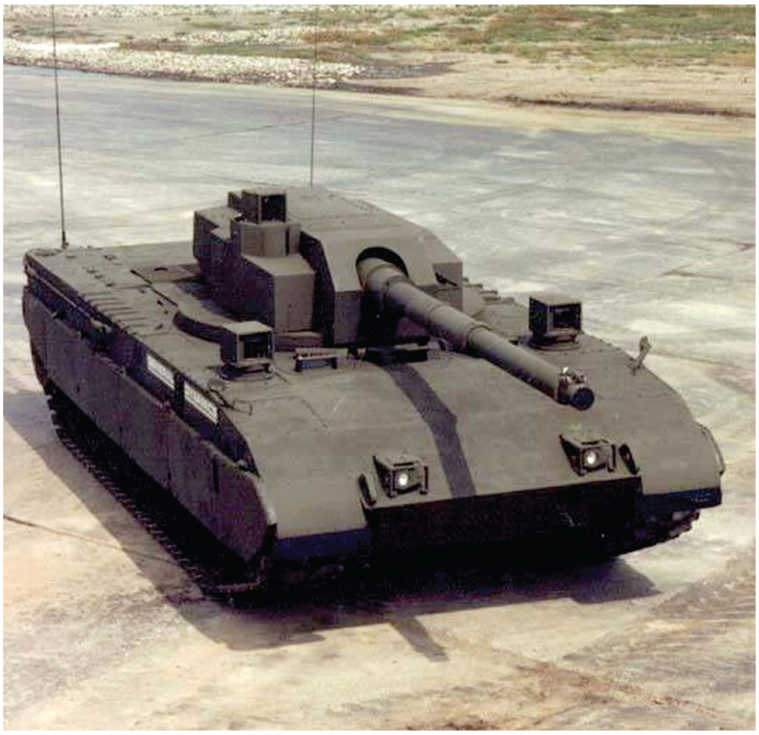
The Surrogate Research Vehicle was a test bed based on the M1 tank to test future crew configurations and their associated electro-optical sensors. As can be seen, three of the crew are located in a capsule in front of the turret area to examine the unmanned turret idea.

The testing of the new 75mm guns was not especially encouraging. The 75mm APFSDS was not very effective in inflicting damage on armored targets when compared to the baseline M774 105mm projectile. The 75mm high-explosive round was found to be more effective against tank targets when used in automatic mode since it could damage sensors, tracks, and other components even if it could not penetrate tank armor. However, the 75mm high-explosive round was not effective against bunkers and only moderately effective against buildings.

Due to the success of the light/medium test beds in the late 1970s, in the early 1980s, TACOM (Tank Automotive Command, formerly TARADCOM) Concepts Laboratory decided to build two MBT test beds based on the M1 tank chassis to examine tank subsystems that might be applicable to an upgraded M1 Abrams or a future MBT. General Dynamics Land Systems (GDLS) was awarded a contract in July 1982 to build the SRV (Surrogate Research Vehicle) and the TTB (Tank Test Bed).

The SRV was a test bed used to examine future tank crew configurations, fire controls, and sensors. It was a complementary vehicle to the TTB, with greater emphasis on the electro-optical sensors, and used a laser main gun simulator instead of an actual tank gun. The crew stations were modular and could be moved around to test an ideal configuration. The basic issue addressed by the SRV was whether a tank crew could conduct their fire control tasks using electro-optical sensors alone. This vehicle was delivered to Fort Knox in January 1983 to test the basic crew layout issues. These lessons were used in the design of the TTB prototype.

The M1 TTB was most notable for examining an unmanned turret with the three-man crew located in a crew capsule in the front of the hull. The low-profile turret was armed with an XM256 120mm mm gun, fed by a 40-round autoloader located below it. Three companies competed to develop the autoloader, including Rheinmetall, FMC-Northern Ordnance Division, and Western Design Howden (WDH). The WDH design was selected in 1983, and integration into the TTB began in 1985. The crew capsule in front of the turret had the driver in the center and the commander and gunner on either side. Both the commander and gunner had their own traversable electro-optical sensors on the forward corners of the hull for observation and target engagement. The TTB was largely used to determine the feasibility of unmanned turrets with an autoloader. These technical lessons informed later programs, such as the Armored Systems Modernization program of 1990.



The M1 Tank Test Bed of 1982 was a demonstrator for a future tank with the three-man crew in a forward capsule and an unmanned turret replacing the traditional turret.

CHAPTER SEVEN
OPERATION *DESERT STORM*

On August 2, 1990, the Iraqi army overran Kuwait, spearheaded by T-72 tanks of the Republican Guards. President George Bush proclaimed, "This shall not stand," and the United States began mobilizing its allies to create a coalition to liberate Kuwait. Saddam Hussein had picked a particularly bad time to provoke the US and its allies, as the climax of the Cold War meant that there was a substantial reserve of heavy combat forces in Germany that could be deployed to the Arabian Gulf. The American strategic concern was not simply Kuwait; there was concern that Iraq would use Kuwait as a springboard to cause further trouble in the region, potentially a seizure of the Saudi oilfields nearby. This threat was so serious that Saudi Arabia quickly joined the anti-Iraq coalition and pressured other Arab states to do so as well, including Egypt and Syria.

IRAQI STRATEGIC PLANS

Saddam Hussein seriously underestimated US resolve and so was obliged to reinforce his occupation of Kuwait, awaiting "the Mother of all Battles." This lull provided the US Army and US Marine Corps with nearly six months to build up forces in Saudi Arabia. The two most obvious coalition operations for liberating Kuwait were a thrust directly into Kuwait, or an envelopment of Kuwait through the trackless western Iraqi desert. Hussein and many Iraqi generals did not believe that the coalition forces could conduct complex mechanized operations in the deep desert, so the focus of the Iraqi deployment was defense-in-depth of the Kuwaiti frontier. The Iraqi army's operational plans reflected the Iran war lessons and began with an initial line of resistance formed of second-rate regular army divisions and melodramatically dubbed "the

Line of Death." A second line of the better regular armored divisions provided a tactical counterattack force, and a third line of the RFGC ((Iraqi) Republican Forces Guards Corps) divisions in the operational depth provided a reserve for reinforcement and counterattack.

Due to the limited capabilities of the regular Iraqi divisions, the Iraqi plan depended on static defense with an emphasis on the use of dug-in tanks and extensive obstacle barriers. This tactical pattern was simple enough for poorly trained troops to carry out, and it had proven very successful against Iranian infantry formations. Tanks were dug in to a hull-down position with only their turrets exposed, or parked behind sand berms. Minefields, anti-tank ditches, and other obstructions were created along the initial line of resistance on the Kuwait frontier, and this sector was surveyed for pre-planned artillery strikes.

A fatal flaw in the eventual RFGC deployment was that it placed three of the best heavy divisions stacked in depth, starting with the Tawakalna, then the Medina, and finally the Hammurabi behind the Rumaylah oilfields.

Although the Iraqi armed forces anticipated a coalition air attack as part of the campaign, they had never experienced a major air assault during the Iran–Iraq War and underestimated coalition airpower. While there were few expectations that the air defense network would totally shield the Iraqi army, Iraqi leaders expected that it could inflict significant aircraft losses and that the Iraqi ground units could endure what survived.

THE US/COALITION PLAN

The US plan assumed that action would be taken against the Iraqi army along the Kuwaiti frontier, but that the primary thrust would be conducted into the western Iraqi desert to envelop and destroy the Iraqi army in Kuwait from the flank. The plan also included a significant deception effort aimed to convince Hussein that the main thrust would be directed into Kuwait.

The right wing of the coalition assault into Kuwait consisted of two US Marine divisions with two Arab Joint Forces Commands (JFC) providing formations on either side. The US Third Army controlled two corps on the left flank facing directly into the western Iraqi desert. The VII Corps was the primary heavy maneuver force and included two US and one British armored division, two mechanized divisions, and an armored cavalry regiment. On the far left flank was the light maneuver force, the XVIII Airborne Corps, which included two US airborne/airmobile divisions, a mechanized division, an armored cavalry regiment, and a French mechanized division. The Third Army's two corps were deployed deep in Saudi Arabia through January 1991 and began moving into strike position only in the weeks prior to Operation *Desert Storm* in hopes of maintaining the ruse.

A key element in the coalition plan was the incorporation of a significant pre-ground-attack air campaign to attrite the Iraq forces. This was conducted by coalition aircraft based in Saudi Arabia, from aircraft carriers in the Arabian Gulf, and from more distant bases such as Diego Garcia. Analysts at the time felt that a force ratio of 3:1 in favor of the attacker was needed to overcome a determined defense. Iraqi forces in the Kuwait theater enjoyed a marginal superiority in personnel, tanks, and artillery over coalition forces in January 1991; the air attacks were intended to shift the balance in favor of the coalition.

IRAQI TACTICAL ORGANIZATION

Organizationally, the Iraqi army relied on British organizational practices, with its tactical doctrine influenced by later Soviet, Jordanian, and Indian advisers. The basic tactical formation was the brigade (*Lawae*), and these were generally collected into divisions with three brigades per division. The brigades in turn consisted of a number of *Katiba*, which is often translated as regiment but which were closer in strength to a US battalion, nominally 55–60 tanks in three companies. The actual strength of Iraqi tank battalions is not known in detail. One battalion of the Tawakalna Division had only about 40 tanks according to its commander; some regular army battalions had only around 35. In general, the RFGC divisions had the better equipment, usually T-72 tanks and BMP-1 infantry fighting vehicles, while the regular army divisions would have T-55, T-62, or Chinese Type 69 tanks along with Chinese armored personnel carriers or cheap Soviet MT-LB transporters. A few of the better regular army formations, such as the 3rd Saladin Armored Division, had at least one battalion of T-72 tanks, and conversely some RFGC brigades had T-62 tanks. A typical armored brigade would include two or three tank battalions and a mechanized infantry battalion; a mechanized brigade would reverse the balance of tank and mechanized infantry battalions. A fully equipped RFGC armored division might have about 220 T-72 tanks. Three of these RFGC heavy divisions saw combat in 1991 – the Hammurabi RFGC and Medina-Manarawah armored divisions, and the Tawakalna-al-Allah mechanized division. In total, about 21 T-72 tank regiments saw service in the 1991 war, totaling close to a thousand T-72 tanks.

Iraqi tactical doctrine was a combination of British practices influenced by Soviet doctrine and the experiences of the 1980–88 war with Iran. In a defensive engagement, Iraqi tank regiments preferred to fight enemy tank units from static positions due to the limitations of their small unit training. Iraqi doctrine favored reverse-slope defense, with the unit positioned down the opposite side of a ridge or hill. The aim of this tactic was to ambush an enemy tank formation as it crested the hill or ridge, at which point the lead tanks could be picked off by the stationary tanks positioned below. At the same time, following waves of enemy tanks would have no ability to locate and identify the Iraqi tanks until after they had crested the hill, at which point they would still be vulnerable to Iraqi fire. This tactic minimized the tactical shortcomings of the Iraqi tankers, such as poor gunnery training, and placed minimal demands on the crew. The gunner would be instructed in advance of the range to the target, and so the gun could be battle-sighted to engage at a predetermined range without the need for range input data which would slow a poorly trained crew. To improve their survivability, Iraqi tanks were often dug-in in advance by combat engineer units, which reduced the vulnerability of the hull to enemy fire and minimized the target presented to enemy gunners. The use of prepared defensive positions was especially common in the regular army armored divisions along the Kuwaiti border. As will be related below, the RFGC divisions in the Iraqi desert moved forward from prepared positions, but even in these circumstances, the tank regiments attempted to create fixed defensive positions using available engineering assets as well as the scraper blade fitted to the front hull of the T-72 tank.

Iraqi doctrine contained a traditional combined-arms component, with tank units often supported by an inter-mixture with infantry. This included dismounted infantry with large quantities of RPG-7 anti-tank rockets, as well as their supporting BMP-1 infantry fighting vehicles. Likewise, Iraqi doctrine placed great faith in artillery support of the forward tank positions. In spite of substantial reserves of good-quality artillery pieces, Iraqi artillery support was severely compromised by the poor quality of Iraqi training and overreliance on tactics perfected against the Iranians. The Iranian army was primarily an infantry force, so Iraqi artillery doctrine favored the use of pre-registered kill zones that could be prepared in advance of the enemy attack and which placed very limited demands on the Iraqi fire direction network. However, such tactics were poorly suited to engaging a fast-moving mechanized force, as would become blatantly apparent in 1991. Iraqi doctrine did not place significant emphasis on close-air support, as the Iraqi air force had seldom shown the capability to conduct such tactics. While some Mi-24 attack helicopters were available in the combat theater in 1991, they played little or no role in the ground campaign nor did fixed-wing strike aircraft.

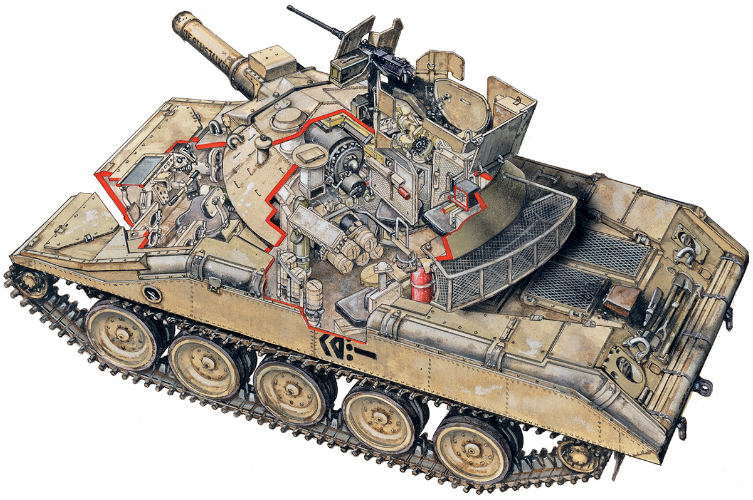
The first tanks to arrive during Operation *Desert Shield* were the M551A1 Sheridans of 3/73rd Armor, 82nd Airborne Division. One is seen here off-loading from a C-130 transport aircraft.

US TACTICAL ORGANIZATION

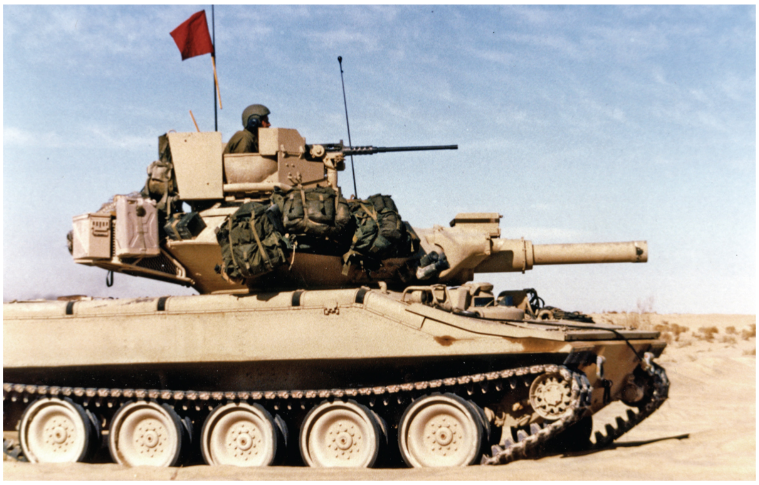
Following the Iraqi invasion of Kuwait in August 1990, the 82nd Airborne Division was air-landed to provide an immediate barrier force against any possible incursion by the Iraqi army. The air-landed Sheridans of the 3/73rd Armor were the only US tanks in Saudi Arabia until further forces could be moved by sea. The 3/73rd Armor was initially equipped with its existing M551A1 tanks, but as the upgraded M551A1s(TTS) were completed at the Anniston Depot they were shipped to Saudi Arabia. Eleven M1047 LAVs were deployed as a scout platoon of 3/73rd Armor during *Desert Storm*.

The first M1 Abrams units to arrive in Saudi Arabia were the battalions of the 24th Infantry Division (Mechanized), which still had older M1 and IPM1 tanks. By November 1990, there were 580 M1/IPM1 tanks in Saudi Arabia and only 123 new M1A1 tanks. As the likelihood of ground war increased, the army re-equipped as many units as possible with the M1A1, preferably the latest M1A1HA version. Since there were not enough M1A1HAs available, a retrofit program was begun to upgrade M1A1 tanks with the heavy armor package; a total of 835 of these upgrades were completed, and they also included fire control upgrades, an NBC system heat exchanger, repainting with Chemical Agent Resistant Coating (CARC) tan desert camouflage paint, and a number of other improvements. This version had no specific designation but is sometimes called M1A1 (mod) or M1A1HA; the chart lists them as M1A1 (mod) to identify the units that used them, but elsewhere in this book they are simply called M1A1HA since they were virtually identical in performance and features. Only two battalions still had the M1 tank at the time of the start of the ground campaign. By February 1991, the US Army had deployed 1,966 M1A1 tanks to Saudi Arabia (733 M1A1, 1,233 M1A1HA), plus 528 other tanks in war reserve stock not attached to combat units. Other upgrades were applied to the M1A1 fleet in the months prior to the fighting, including the dispatch of the improved T-158 track.

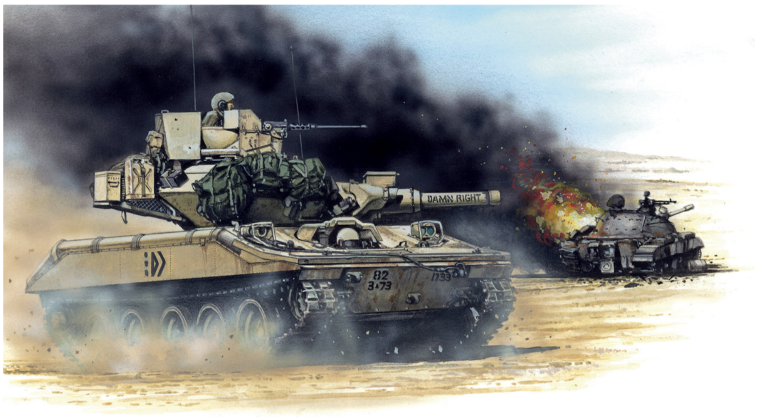
US Army armored divisions were organized with six armor battalions and four mechanized infantry battalions, while the mechanized infantry divisions had the reverse mix of six mechanized infantry and four armor battalions. It should be noted that US heavy battalions relied on regimental lineage; for example, 2/67th Armor refers to 2nd Battalion, 67th Armored Regiment. The armor battalions had a headquarters company with two M1A1 tanks and four tank companies, each with 14 M1A1 tanks for a total of 55 tanks. The armored divisions were in turn organized into three combined-arms brigades (comparable to the World War II Combat Command) and typically consisting of two armor battalions, a mechanized infantry battalion, a self-propelled 155mm artillery battalion, and an air defense battery along with supporting elements.



M551A1 (TTS), 3/73rd Armor, 82nd Airborne Division, Operation *Desert Storm*, 1991. (Artwork by Tony Bryan © Osprey Publishing)



Although first deployed to Saudi Arabia with the M551A1 in 1990, the 3/73rd Armor was re-equipped with the upgraded M551A1(TTS) as quickly as it was remanufactured at the Anniston Depot.



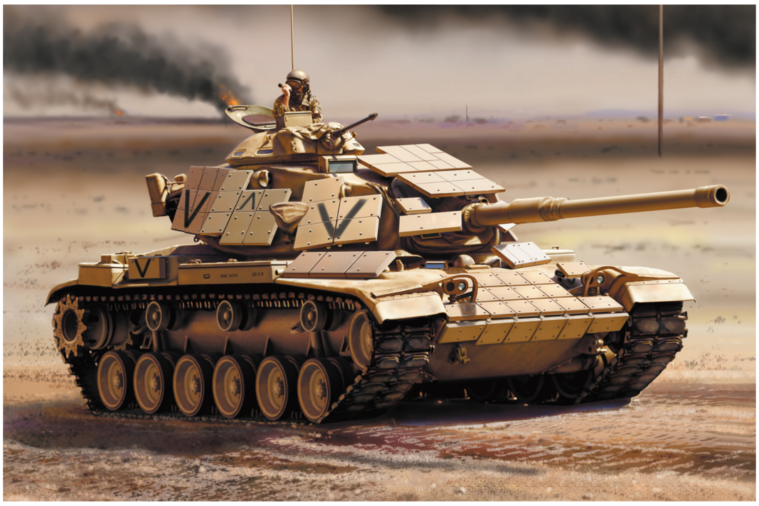
M551A1(TTS), 3/73rd Armor, 82nd Airborne Division, Operation *Desert Storm*, 1991. (Artwork by Tony Bryan © Osprey Publishing)

The 2nd Iron Brigade of the 1st Armored Division provides a good example. It had three tank battalions (2/70th Armor; 4/70th Armor; 1/35th Armor) and one mechanized battalion (6/6th Infantry), supported by the 47th Support Battalion and 2/1st Field Artillery. The battalions in turn were mission organized into combined arms task forces; so Task Force 2/70th Armor (TF 2-70) consisted of three Abrams tank companies – A, B, and D– and one Bradley mechanized company, Co. C, 6/6th Infantry, for a total of 44 tanks and 13 Bradleys.

The first division with M1 tanks to arrive in Saudi Arabia in 1990 was the 24th Infantry Division (M), which was still equipped with the 105mm M1 and IPM1 tanks, such as this tank from Co. D, 4/64th Armor. They were re-equipped with the M1A1 later in the year. (US Army)

In the open desert, TF 2-70 moved in a modified diamond formation. Team Bandit (Co. B, 2/70th Armor) led with Team Desperado (Co. D, 2/70th Armor) on the right, Team Assassin (Co. A, 2/70th Armor) on the left, and Team Bayonet (Co. C, 6/6th Infantry) in the rear, with battalion trains and headquarters in the center of the formation. Team Bandit, which will be the focus of the duel described from here, consisted of 14 M1A1 tanks, an engineer company, and an M88 recovery and medic vehicle, with its remaining organic M88 and ambulance in the company trains.

At the start of Operation *Desert Storm*, the US Marine Corps still relied on the older M60A1 RISE (Passive) while awaiting delivery of the M1A1 tank. Many of these were upgraded with explosive reactive armor for added protection against anti-tank missiles. (USMC)



M60A1 RISE (Passive), US Marine Corps, Operation *Desert Storm*, 1991. (Artwork by Jim Laurier © Osprey Publishing)

The US Army also deployed two armored cavalry regiments to Saudi Arabia – the 2nd and 3rd ACR – one with each corps. Such regiments had three armored cavalry squadrons, each with three armored cavalry troops with nine Abrams and 12 Bradleys. So, a squadron had 41 Abrams and 32 Bradleys, while the regiments totaled 116 M1A1 Abrams and 132 M3 Bradleys. The chart lists the squadrons as battalions for simplicity, though it should be noted that they had fewer Abrams than an armor battalion.

The US Marine Corps tank battalions in Operation *Desert Storm* were equipped primarily with the older M60A1 RISE (Passive) tank, amounting to 277 of the 353 tanks deployed. The Marines were still awaiting delivery of the M1A1 Common. The Marine 2nd Tank Battalion was equipped with the M1A1HA borrowed from the Army, while the two companies of the Marine Reserve 4th Tank Battalion had the new M1A1 Common Tank. In total, the USMC deployed 76 M1A1 tanks in Operation *Desert Storm*, consisting of 60 M1A1HA and 16 M1A1 Common Tanks.

US Army “AirLand Battle” doctrine was the culmination of more than a decade of intense debate over the ideal methods to deal with a Warsaw Pact campaign in central Europe. Although primarily defense in orientation, the doctrine did contain a strong emphasis on mobile counterattack and extremely aggressive tactics, and due to the high level of training at all levels, this could be easily adapted to an offensive campaign. The US Army doctrine placed great stress on combined arms in the broadest sense of the term. The doctrine presumed a very heavy employment of airpower to attrite the enemy forces before contact with the ground element. In addition, the US Army had spent a tremendous amount of human and material capital to build up an organic aviation element within the heavy maneuver divisions, notably a battalion of AH-64 Apache attack helicopters. These provided the divisional commander with a powerful air cavalry force that could provide flexible flank security during mobile operations as well as substantial anti-armor capability to amplify the attritional power of airpower in the close battle where the US Air Force was less comfortable operating.

A Marine M60A1 with the Appliqué Armor kit leads a column of AAV-7A1 amtracs of the 2nd Marine Expeditionary Force in February 1991 at the start of Operation *Desert Storm*.

The advent of the M1 Abrams tank and M2/M3 Bradley Infantry/Cavalry Fighting Vehicle accompanied a doctrinal evolution that increased the tempo of small-unit tactics in direct combat since both categories of combat vehicle could fight on the move. This tactical innovation was stressed in training since the high speed of an assaulting force could help debilitate a slower-reacting opponent, and speed could reduce the vulnerability of the attacking force to enemy weapons if properly exploited.

This would become very apparent in combat with the Iraqi forces, which were unable to react quickly enough to deal with US Army offensive tactics. The forward maneuver units were further enhanced by the substantial firepower of the divisional artillery, which had undergone an important renaissance in the 1970s and 1980s in terms of equipment, munitions, and fire direction. This broad modernization of technology and tactics amplified the advantage of Abrams tank battalions over Iraqi opponents, since the Iraqi units had usually suffered from the violent preparation of the battlefield by airpower, attack helicopters, and artillery even before making contact with US tank units. In contrast, Abrams tank battalions could usually operate free from enemy air attack, and Iraqi artillery presented little threat both due to inherent tactical weaknesses and their short life expectancy once engaged by US counter-battery fire.

M1 Abrams tank battalions, Operation *Desert Storm*

	M1	M1A1	M1A1 (mod)	M1A1HA	M1A1 Common	Total
1st Armored Division		3	2	1		6
3rd Armored Division		3		3		6
1st Cavalry Division			4			4
1st Infantry Division	2		2	2		6
24th Infantry Division			4			4
Tiger Brigade (2nd Armored Division)			2			2
2nd Armored Cavalry Regiment				3*		3
3rd Armored Cavalry Regiment				3*		3
US Marine Corps				1	1**	2
Total	2	6	14	13	1	36

*Armored cavalry regiments were organized with three squadrons with 41 M1A1HA each **Only two companies

THE CAMPAIGN

The *Desert Storm* air campaign began on January 17, 1991, and continued for 35 days. The US Air Force later claimed that 40 percent of the tanks and 35 percent of the other armored fighting vehicles had been knocked out in the air attacks. This assessment was later judged to have been too optimistic. The US Marine Corps estimated that 10–15 percent had been knocked out in Kuwait, while the US Army estimated about 15–25 percent in the western Iraqi desert. The lowest accounting comes from a Russian assessment, which estimated 3,700 tanks in the combat zone at the outset of the air campaign and 3,400 at the end.

Regardless of the precise number of tanks knocked out by air attack, the air assault devastated the Iraqi army. The relentless bombing thoroughly demoralized the Iraqi troops and led to widespread desertion. A Russian assessment concluded that Iraqi strength in the combat zone dropped from 790,000 troops at the outset of the campaign to about 400,000 when the ground campaign began on February 24, 1991; some US estimates suggested Iraqi strength may have only been half this number. The air campaign also devastated the Iraqi logistics network, making supply of many units difficult. The attacks had their greatest impact on the poorly trained and poorly motivated conscript troops in the frontline divisions in Kuwait, and had far less effect on the better-motivated RFGC troops in the army reserve farther back from the frontlines.

An M1A1 on training prior to the start of Operation *Desert Storm* with its smoke generation system turned on.

PENETRATOR

"Penetrator," an M1A1HA of the 2nd ACR, emplaced behind a berm at the start of Operation *Desert Storm.*

G-Day, the start of the ground campaign, began at dawn on February 24, 1991, with the XVIII Airborne Corps assault on the western flank of the coalition, while the Joint Forces Commands and US Marine Corps began breaching operations against the thickest Iraqi defensive belts along the Kuwaiti frontier. Of the 36 Abrams battalions/squadrons in Operation *Desert Storm*, seven served with the XVIII Airborne Corps on the left flank, 25 with the VII Corps in the center, and four with the Marines on the right flank along the Kuwaiti border. Since the main concentration of the best Iraqi armored units faced the VII Corps, this sector is the focus here.

The primary mission of the VII Corps was to rapidly breach the Iraqi frontier defenses, race through the Iraqi desert to the west of the Kuwaiti frontier, and then envelop and destroy the Republican Guards divisions that served as the Iraqi army's main reserve.

The original plan expected the VII Corps to begin its attack on G+1, but the unexpectedly rapid penetration of Iraqi defenses on the Kuwaiti frontier by the Marines accelerated the plan and led to initial breaching maneuvers on G-Day afternoon, with the 2nd Armored Cavalry Regiment in the lead followed by the corps' heavy maneuver divisions.

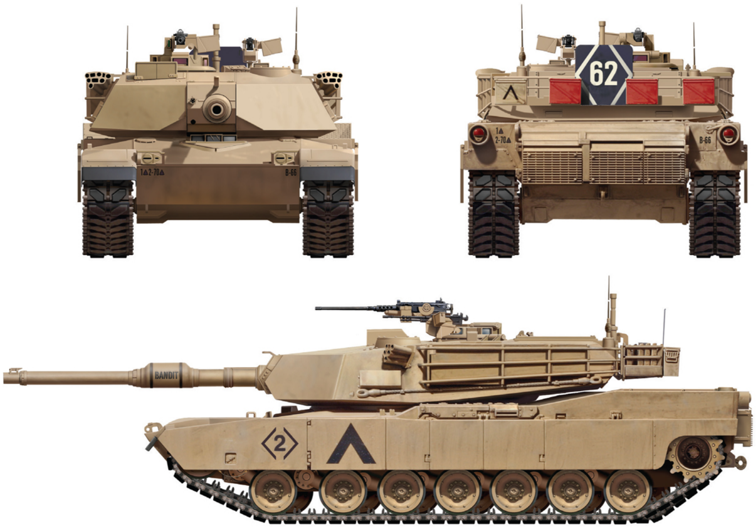
This massive force overran two brigades of the Iraqi 26th Infantry Division with few signs of coherent resistance or effective artillery.

Final Option
Fb

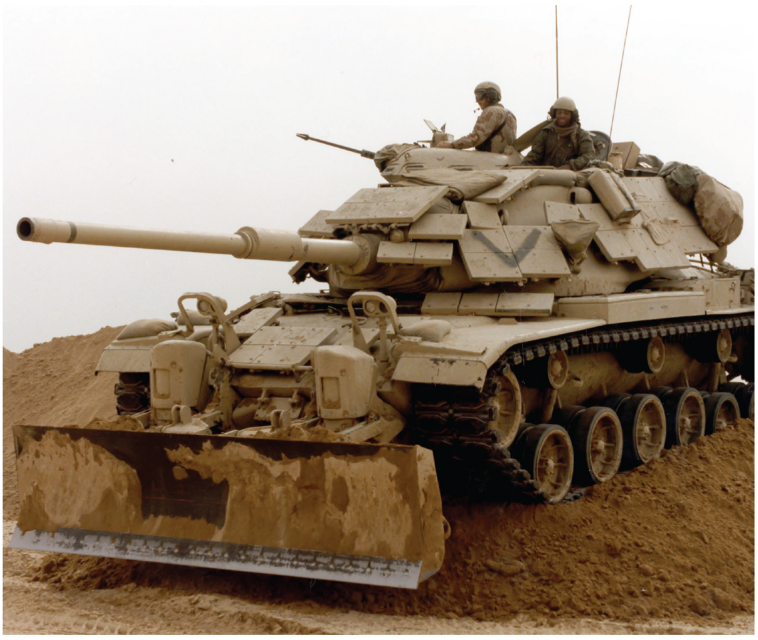
An M1A1 named "Final Option" of F Troop, 3rd ACR, which served with the XVIII Airborne Corps on the left flank of the coalition assault. (US Army)

Behind the thin crust of defenses along the border was the Jihad Corps, including the 10th and 12th Armored Divisions subordinate to Gen. Ayad Al-Rawi, commander of the RFGC. By late on February 24, Al-Rawi was well aware of the advance of the XVIII Airborne Corps, but the late launch of the VII Corps, the poor weather, and the annihilation of the 26th Infantry Division left him blind about the massive force heading toward his command. The threat posed by the coalition forces prompted him to dispatch two armored brigades of the 12th Armored Division and one from the 10th Armored Division to cover the Wadi al Batin along the western Kuwaiti border and to serve as a shield while he reoriented the RFGC heavy divisions toward the threat. The weather was "more like Germany than Arabia," in the words of one American tanker – cold, windy, rainy, and overcast. The heaviest fighting on G+1 erupted along the corps' right flank as the US 1st Infantry Division continued the breach of the 26th Infantry Division defensive lines in preparation for exploitation by the British 1st Armoured Division. The Iraqi 7th Corps attempted to stem the advance by deploying its tactical reserve, the 52nd Armored Division, which became entangled and smashed in a one-sided night fight with British

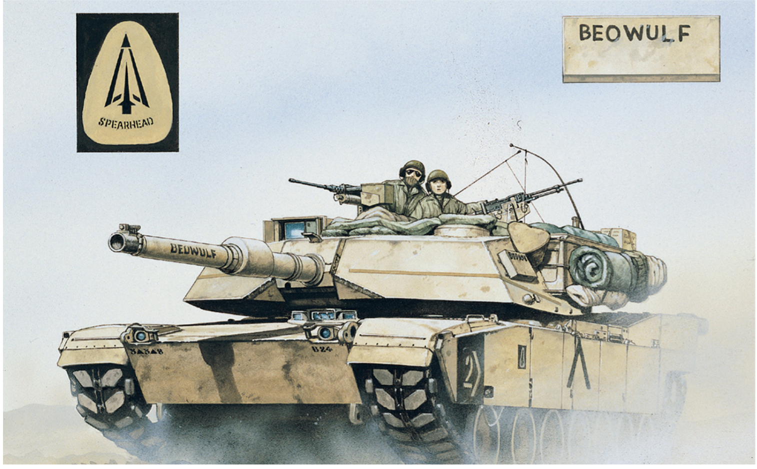
Challenger tanks late on February 25. By midnight of February 25/26, most of the Iraqi 7th Corps had been routed.



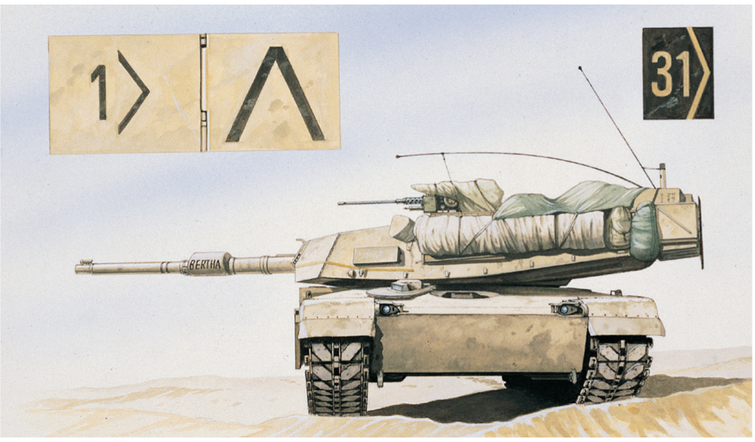
M1A1, 2/70th Armor, 1st Armored Division. (Artwork by Jim Laurier © Osprey Publishing)



A Marine M60A1 with Appliqué Armor during Operation *Desert Storm* in February 1991. The US Marine Corps deployed this kit on the M60A1 tanks of the 1st and 3rd Tank Battalions, in this case, a dozer-equipped tank.



M1A1, 3/8th Cavalry, 3rd Armored Division, KTO, 1991. (Artwork by Peter Sarson © Osprey Publishing)



M1A1, 3/2nd Armored Cavalry, Battle at 73 Easting, 1991. (Artwork by Peter Sarson © Osprey Publishing)

Around noon on February 25, G+1, the 2nd ACR started bumping into the advance elements of the 50th Brigade, 12th Armored Division, and began a one-sided engagement against a battalion of T-55 tanks and MT-LB armored transporters. The Abrams and Bradleys fought for the remainder of the day against scattered armored and infantry elements of the Iraqi division, significantly weakening one of its brigades. A small number of T-72 tanks were encountered late in the day, most likely advance elements of the RFGC Tawakalna Division. The US Army 1st Armored Division completed the destruction of the hapless 26th Infantry Division, overrunning its surviving brigade. For most of G+1, the long columns of Abrams and Bradleys advanced at a rapid pace, screened by scout helicopters and AH-64 Apache attack helicopters.

During the evening of February 25, Gen. Fred Franks, VII Corps commander, approved Frag Plan 7, which started the "Great Wheel" of the 2nd ACR, as well as the 1st and 3rd Armored Divisions and 1st Cavalry Division to the east, along a phase-line to attack the RFGC corps. In the meantime, Gen. Al-Rawi had ordered three RFGC heavy divisions to begin to reposition themselves to counter the rapidly approaching VII Corps. The Tawakalna Mechanized Division was placed in a defensive blocking position on the western Kuwaiti border with surviving elements of the 12th Armored Division to its south, and the 10th Armored Division behind it to its east. The Medina and Hammurabi Armored Divisions were placed north on either side of the Rumaylah oilfields. This set the stage for the most intense tank fights of Operation *Desert Storm*.

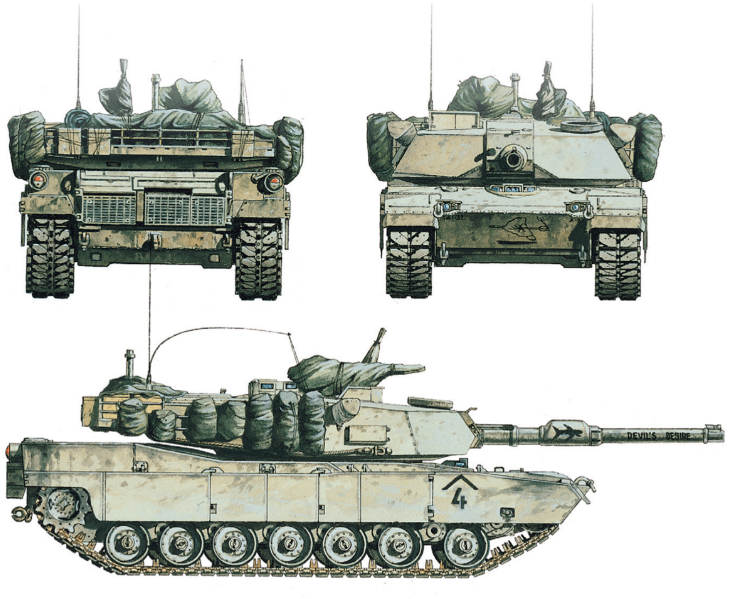
The 2nd ACR continued the advance around 0600 hours on G+2, encountering isolated T-55 tanks and MT-LB transporters from the 12th Armored Division's remaining brigades. The increasing numbers of better vehicle types, including T-72 tanks, hinted at a growing RFGC presence. The intensity of the fighting increased to the point that the regiment became convinced it had entered the outer security zone of the RFGC Tawakalna Division. By mid-afternoon, the regiment with the neighboring 3rd Armored Division on its left encountered dug-in T-72 tanks and BMP-1 infantry fighting vehicles. Although much of the Iraqi army was in full-scale retreat from Kuwait, the Tawakalna Division showed every sign of staunchly defending the line against the VII Corps. Besides its own battalions, the Tawakalna Division had served as a collection point for battalions of the 12th Armored Division, which they incorporated into their defense.

A US Marine M1A1HA passes a revetted Iraqi truck. The Marine 2nd Tank Battalion borrowed M1A1HA tanks from the Army until the M1A1 Common became available after the conflict. (USMC)

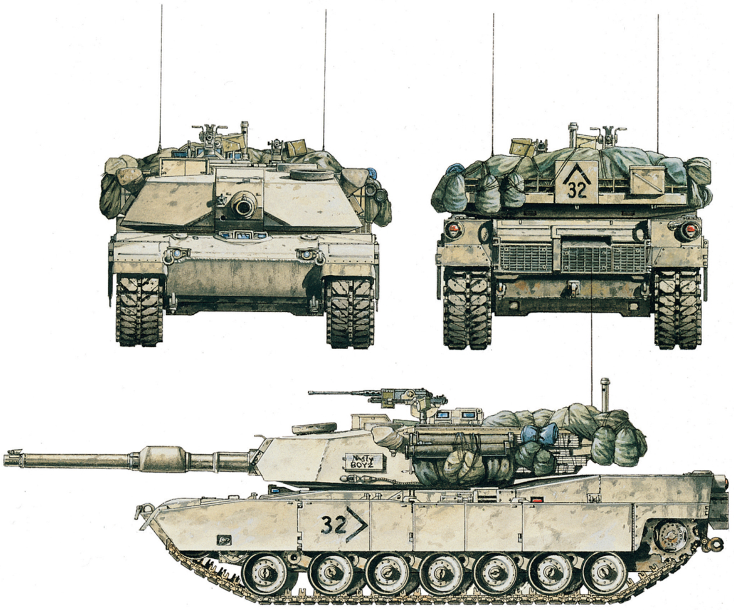
73 EASTING

The fighting intensified in the late afternoon when 2nd ACR encountered elements of the Iraqi 9th Armored Battalion and 18th Mechanized Battalion on the left flank of the Tawakalna Division in prepared positions to the west of the IPSA pipeline. E Troop and I Troop fought a series of skirmishes from around 1530 hours, pushing through the Iraqi position and reaching the 73 Easting gridline before being counterattacked by a company of T-72 tanks, which were destroyed by M1A1 tanks at 2,100 meters. The Iraqi defense position lacked an adequate security zone in front, so when the American vehicles arrived out of the rain and mist, they were completely unexpected. Some Iraqi crews were huddled down in trenches due to earlier air attacks in the area, and never managed to get back into their vehicles. Other tanks did fight back, but they could barely see the attacking American force, and they failed to properly adjust for range, hitting the ground well in front of the US Army vehicles with their sabot rounds.

As the smoke cleared, the 18 M1A1 tanks and 24 M3A1 Bradleys had destroyed more than 30 dug-in T-72 tanks and 12 BMP-1s at no loss to themselves. The mechanized infantry battalion commander captured by E Troop said that he had started the fight with 900 soldiers, a few dozen BMP-1s, and an attached battalion of 36 tanks; when he was captured, all that survived were the 40 soldiers with him. A stunned Tawakalna tank battalion commander added, “When the air campaign started, I had 39 [T-72] tanks. After 38 days of the air battle, I had 32 tanks. After 20 minutes against them [the 2nd Armored Cavalry Regiment], I had zero tanks.” After dark, 1/1st Aviation’s Apache helicopters struck the second tactical echelon of these brigades, causing heavy losses to three emplaced battalions.



M1A1, 1/37th Armor, 1st Armored Division, KTO, 1991. (Artwork by Peter Sarson © Osprey Publishing)



M1A1, 3/66th Armor, 1st Infantry Division, KTO, 1991. (Artwork by Peter Sarson © Osprey Publishing)

As contact with the Tawakalna Division developed, the 1st Infantry Division passed through the overworked 2nd ACR in the dark to prepare for the following day's attack. In the process, two Bradleys conducting forward reconnaissance were silhouetted against the skyline by the burning wrecks of Iraqi vehicles and were hit by vehicles of the RFGC 18th Mechanized Brigade. The 3rd Brigade, 1st Infantry Division, confronted an Iraqi regiment shortly before midnight along the IPSA pipeline and destroyed about 60 tanks and 35 infantry vehicles. The chaotic battlefield was littered with destroyed Iraqi equipment, burning wrecks, hidden Iraqi tanks in revetments, and roaming Iraqi RPG anti-tank rocket teams. One Abrams battalion remembered it as "Fright Night." During the fighting, M1A1 tanks mistakenly engaged friendly forces on several occasions, knocking out five other M1A1 tanks and two Bradleys; fratricide proved more costly than Iraqi actions. Friendly fire incidents would continue to be a significant hazard due to the intermingled US and Iraqi forces, as well as a chaotic battlefield obscured by darkness, rain, and sandstorms. By dawn of G+3, the 2nd ACR and 1st Infantry Division had destroyed most of four Iraqi tank and mechanized brigades and had cracked open the left flank of the RFGC defensive belt.

In the center, the US 3rd Armored Division hit the right flank of the Tawakalna Division in the late afternoon of G+2, pitting about eight Iraqi tank and mechanized battalions with 122 tanks and 78 BMPs against ten US heavy battalions. The fighting was not entirely one-sided. A troop of Bradleys from 4/7th Cavalry engaged a well-entrenched Iraqi position, and nine of its 13 Bradleys were damaged before the unit withdrew; two more were victims of fratricide. Indeed, the Iraqi resistance was fierce enough that 1st Brigade, 3rd Armored Division temporarily halted the attack that night. The neighboring 2nd Brigade fought its way through much of the Iraqi 29th Mechanized Brigade defenses by the early morning hours of February 27.

The right flank of the Tawakalna Division, a tank battalion of the 29th Mechanized Brigade supported by a BMP company, was overwhelmed on the evening of February 26 by the 3rd Brigade, 1st Armored Division, with 24 T-72s and 14 BMP-1s knocked out; four M1A1 tanks were mistakenly hit by Hellfire missiles from Apache helicopters but without crew injuries. The division's other two brigades continued to advance eastward that night, aiming at the RFGC Medina Division.

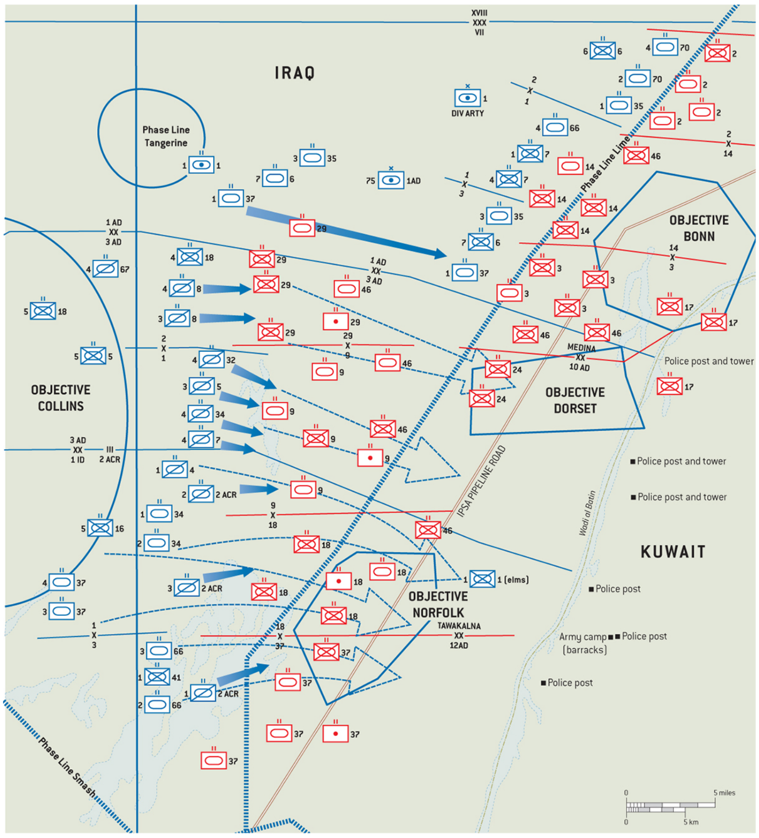
By midnight of G+2, after less than 30 hours of fighting, the Tawakalna Mechanized Division had been destroyed bit by bit by the overwhelming force of three US Army heavy divisions and the 2nd ACR. In contrast to the press accounts which suggested that most Iraqi units bugged out and ran at the first opportunity, the Tawakalna fought tenaciously; nevertheless, its sacrifices were largely in vain due to its poor tactical skills.

MEDINA RIDGE

On the VII Corps' left flank, two brigades of the 1st Armored Division continued to move forward on the night of February 26/27 in anticipation of encountering the RFGC Medina Armored Division on the outskirts of the Rumaylah oilfields. Gen. Al-Rawi had dispatched a brigade of the Adnan Motorized Division to serve as a covering force, but it was identified during its movement forward and shattered by US artillery fire. By the morning of February 27, the 1st Armored Division called a halt for fueling; M1A1 Abrams tanks typically refueled three times a day during the operation due to the distances covered. In the midst of this operation, 2nd Brigade was brought under intense artillery fire by the Medina Division's artillery regiment, but the Iraqis struck only pre-registered boxes and did not adjust their fire, so the 2nd Brigade emerged from the barrage unscathed. This was typical of Iraqi artillery, which had excellent and plentiful weapons, but poor fire direction skills.

The Medina Armored Division's 2nd Armored Brigade had established a reverse-slope defense, but the site had been poorly chosen, as the ridge it was using to ambush the advancing US force was too far away for its 125mm guns to reach, as it had apparently not bothered to verify the distance. The weather was overcast and wet with poor visibility of only about 1,500 meters. The US 1st Armored Division's 2nd Iron Brigade crested the rise, shortly after noon on February 27. The Iraqis were unaware of their arrival, lacking a proper security zone and unable to see the Abrams due to the weather. The stage was set for the Battle of Medina Ridge.

The Iraqi 2nd Armored Brigade was at about 75 percent strength and equipped with T-72 tanks and BMP-1 infantry fighting vehicles. The vehicles were in static positions, with sand berms surrounding them and only the turret visible. The Iraqis were intimidated by US electronic intelligence capabilities, and the forward screen had their tactical radios turned off as a result. Consequently, when the US TF 2-70 and 4-70 attacked and destroyed the forward screen at 0700 hours, the presence of the Americans went unreported to brigade headquarters. The Iraqis had no idea that enemy forces were so close. At 1130 hours, the Medina brigade crews were cooking rice and chicken on small one-burner stoves near their vehicles.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XXX
VII
IRAQ
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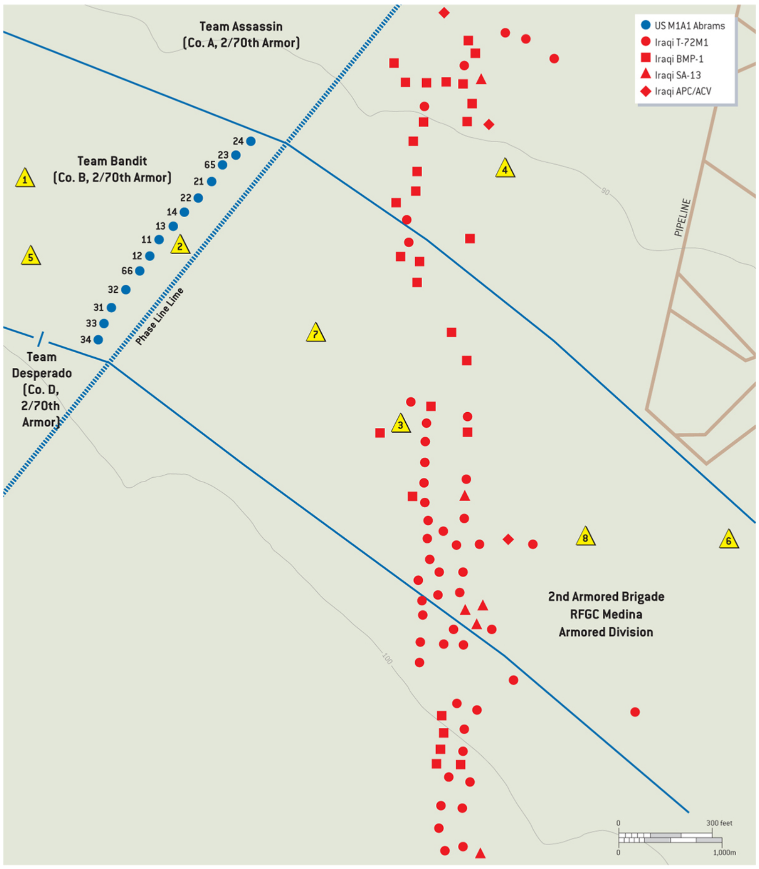
1 ID
2 ACR
MEDINA
XX
10 AD
OBJECTIVE DORSET
Police post and tower
Police post and tower
Police post and tower
IPSA PIPELINE ROAD
Wadi al Batin
KUWAIT
OBJECTIVE NORFOLK
TAWAKALNA
XX
12AD
Police post
Army camp (barracks)
Police post
Police post
Phase Line Smash
0
5 miles
0
5 km

Attack by VII Corps against Iraqi Republican Guards, February 26–27, 1991. (© Osprey Publishing)


Team Assassin
(Co. A, 2/70th Armor)
Team Bandit
(Co. B, 2/70th Armor)
Team Desperado (Co. D, 2/70th Armor)
24
23
65
21
22
14
13
11
12
66
32
31
33
34
Phase Line Lime
1
2
3
4
5
6
7
8
US M1A1 Abrams
Iraqi T-72M1
Iraqi BMP-1
Iraqi SA-13
Iraqi APC/ACV
90
100
PIPELINE
2nd Armored Brigade
RFGC Medina
Armored Division
0
300 feet
0
1,000m

Actions

1. Around 1130 hours, Team Bandit begins approaching Phase Line Lime and begins wheeling to the southeast from a 90 degree to 110 degree orientation.
2. At 1217 hours, M1A1 Tank B11 reports "Contact, tanks, east" and the tank company moves on line.
3. Around noon, the Iraqi battalion is starting to prepare lunch, not having heard a word from an advance security detachment wiped out earlier in the morning. The crews hasten back to their vehicles after the US tanks begin firing.
4. A reserve company of BMP-1s attempts to counterattack by shifting to the north, but is destroyed in movement.
5. Iraqi divisional artillery begins to fall on pre-registered targets, but fails to hit Team Bandit or its trains, and the Iraqis never adjust fire.
6. While Team Bandit is engaged, 1st Armored Division continues deep attack against next echelon of Iraqi forces to the east using MLRS rocket artillery, Apache attack helicopters and F-16 strike fighters.
7. On the command "Assault, assault, assault," Team Bandit advances forward to overrun the Iraqi defensive line.
8. Team Bandit consolidates the objective around 1440 hours.

2/70th Armor, Medina Ridge, February 27, 1991. (© Osprey Publishing)

The American assault on the brigade began at 1145 hours with an M1A1 tank platoon, Team Bandit, in the lead. Cresting a small wash, the M1A1 tanks spotted the bulk of the Iraqi formation in front of them almost immediately and reported, “Contact, tanks, east,” over the company net. Capt. Mark Gerges sent a contact report to the task force commander, requesting confirmation that there were no friendly vehicles to the front. Once this was confirmed, the lead M1A1 tanks began firing at the Iraqi vehicles.

Shortly after noon, the neighboring Team Assassin farther north also spotted tanks and BMPs to its front, about 3,000 meters away. The Iraqi armored vehicles might have been unseen but for the thermal imaging sights on the Abrams tanks that could see through the murk. The experience of M1A1 B66 under Capt. Mark Gerges in the center of the line was typical. Gerges later recounted:

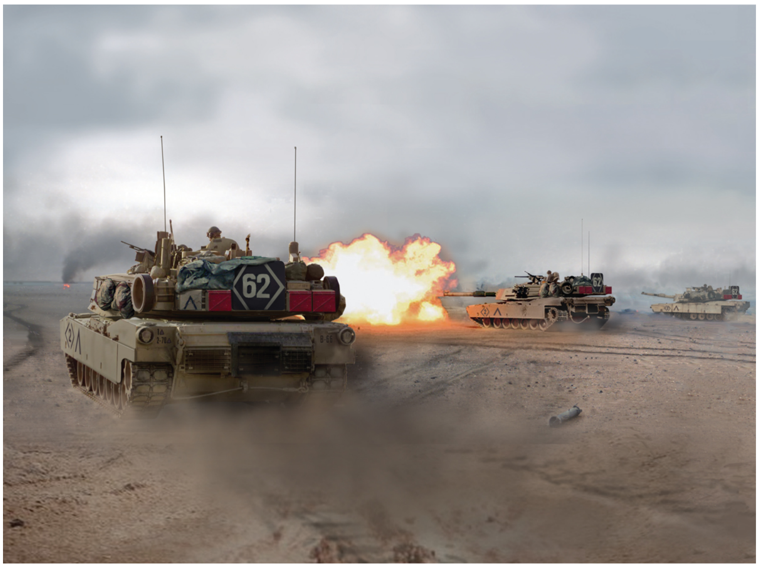
> The tanks alternated firing so that wingmen could observe the splash of a round and call out adjustments if needed. There was little need. The depleted uranium sabot rounds flew practically flat in the two to three seconds it took them to reach the T-72s. There was no arch to the sabots’ trajectory as there had been with training ammunition during gunnery practice in Germany. As a round struck a target, crews observed a flash through the thermal sight from the pyrophoric effect as the depleted uranium penetrator struck the armor.

The sabot penetrations cooked off the T-72 ammunition located in the autoloader under the center of the turret. The spectacular and catastrophic explosions often lifted the turrets 30–40 feet into the air and tore the vehicles apart. The Iraqi crews returned fire, but lacking thermal sights they could fire only at the muzzle flashes in the distance with their projectiles falling a kilometer short.

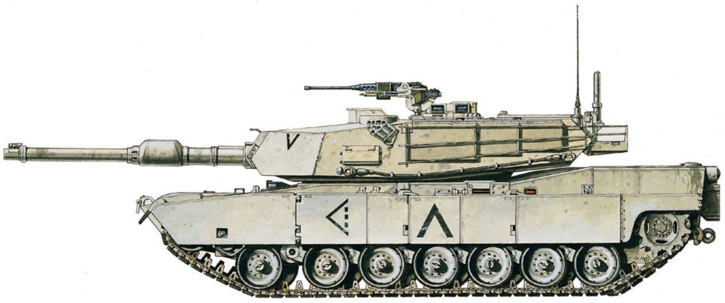
The American firing line comprised three battalions of 2nd Brigade. Within 15 minutes of the start of the firefight, plumes from burning T-72 tanks rose across the front, the area later known as Medina Ridge. TF 2-70 was credited with 59 T-72 tanks, 29 BMP-1s, 6 SA-13s, and four other armored vehicles. After briefly consolidating the position, 2nd Brigade moved farther east 5 or 6 kilometers, halted to refuel, and prepared to continue the attack.

A similar situation prevailed in the 1st Brigade sector facing the Medina's 14th Mechanized Brigade and elements of the 46th Mechanized Brigade of the 12th Armored Division, which were engaged at ranges of 4,000 meters using thermal sights, while the Iraqis were in the process of rearming and refueling their vehicles. The Iraqi units were unprepared for the attack and generally oriented toward the south instead of facing the west where the attack emanated. The 1st Armored Division's 3rd Brigade was the last to crest the ridge around 1300 hours and encountered the 2nd Mechanized Brigade, which it methodically destroyed with long-range gunfire from the M1A1 tanks and TOW missile fire from the Bradleys. By the end of February 27, the 1st Armored Division had largely destroyed the Medina Division, knocking out 186 tanks and 127 armored infantry vehicles.

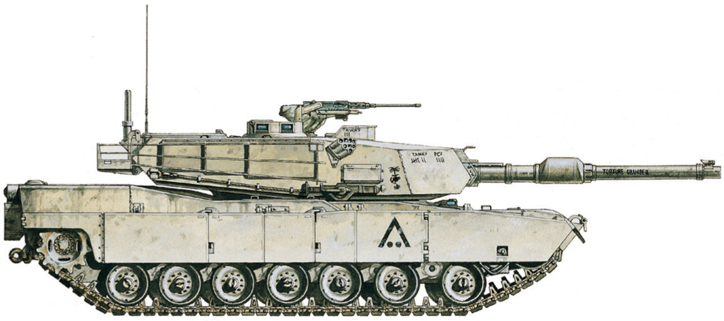
The third echelon of the RFGC was the Hammurabi Armored Division, which was farther west behind the Rumaylah oilfields. This division did not engage US ground forces prior to the ceasefire. However, on the morning of March 2, a significant portion of the division attempted to escape north via an



Battle of Medina Ridge, February 27, 1991. (Artwork by Jim Laurier © Osprey Publishing)



M1A1, 4/64th Armor, 24th Infantry Division (Mech), Battle of Rumaylah, 1991. (Artwork by Peter Sarson © Osprey Publishing)



M1A1, 2nd Marine Tank Battalion, KTO, 1991. (Artwork by Peter Sarson © Osprey Publishing)

elevated causeway over the Hawr-al-Hammar waterway, through a sector controlled by the 24th Infantry Division. The Hammurabi Division had apparently been ordered by Saddam Hussein to escape out of the Basra pocket, as it was needed to help suppress the revolts that were occurring in the Shi'ite regions in southern Iraq. The column was desperate enough to fire on the Bradleys of TF 2-70 and Abrams of TF 4-64 in violation of the ceasefire. The 24th Infantry Division responded by sealing off the causeway using artillery-fired mines, then proceeded to methodically destroy the column. The division's Apaches struck with 107 Hellfire missiles, scoring 102 hits, and the column was then overrun by Abrams and Bradleys, with the Battle of Rumaylah ending in the early afternoon after 187 Iraqi armored vehicles, 34 artillery pieces, and 400 trucks had been destroyed. US losses consisted of a single Abrams burned out when it was set on fire by a massive explosion from a nearby Iraqi vehicle. This was the last tank engagement of Operation *Desert Storm*.

The final tank combat of Operation *Desert Storm* occurred after the ceasefire on March 2, when the Hammurabi Division bumped into the 24th Infantry Division while trying to escape, leading to a short but intense Battle of Rumaylah. This is an M1A1 of Co. C, 4/64th Armor, during the fighting. (US Army)

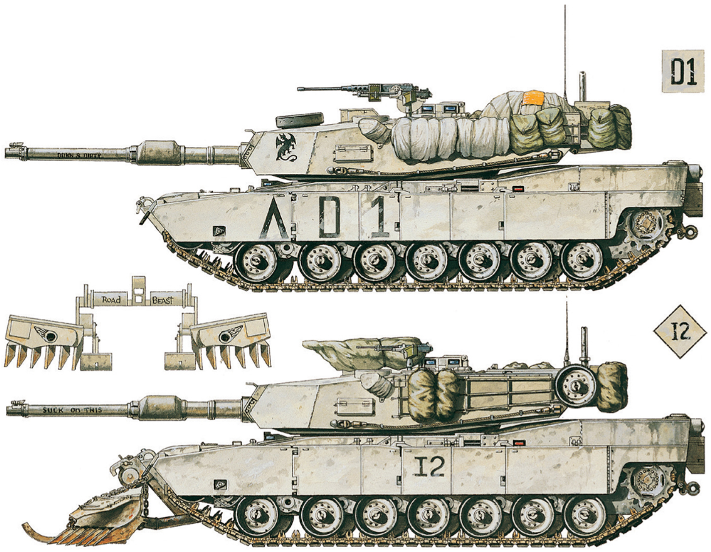
The US Marine Corps' experience with the M1A1 in Operation *Desert Storm* largely mirrored that of the Army, though on a much smaller scale. Bravo Company of the Marine 2nd Tank Battalion had at least one violent confrontation with T-72 tanks of the 3rd Saladin Armored Division in the pre-dawn hours of February 25. The company was coiled up in night defensive positions, with a single crewman in each tank assigned to keep watch using the tank thermal sight. An Iraqi T-72 battalion supported by BTR-63 (Chinese YW531 armored personnel carriers) blindly approached the Marine defenses. An Iraqi lieutenant later recalled what ensued: "Our column was headed across the desert when all of a sudden, the tanks in front of me, to the left of me, and behind me, all blew up." The lieutenant ordered the crew to abandon their T-72, but before they could do so, their tank exploded. The lieutenant, standing in the open hatch, was blown free from the tank, but the gunner and driver were killed instantly. In 90 seconds, 34 of 35 T-72 tanks were knocked out, and then the Marine Abrams turned their guns on the poorly protected armored personnel carriers. One Marine crew was credited with hitting seven T-72 tanks with seven rounds in about a minute's time.

Besides the M1A1 and Marine M60A1 tanks, the only other US tank in service in *Desert Storm* was the M551A1 Sheridan of the 3/73rd Armor. The 82nd Airborne Division was used as a flanking force in the Iraqi desert and overran the remnants of the Iraqi 45th Division. At least one Shillelagh missile was used against an Iraqi T-55 or Type 59, the only time this missile was fired in anger. The Sheridans performed extremely well and there were no mechanical breakdowns.

COMBAT ANALYSIS

The tank fighting during Operation *Desert Storm* was one of the most lopsided contests in 20th-century military history. The Iraqi army was outclassed in all respects and suffered appallingly high losses while inflicting minimal casualties on the coalition forces. In the case of the M1A1, more Abrams tanks were destroyed by friendly fire than Iraqi actions. From later accounts, it would appear that at least seven Abrams were hit by T-72 gunfire; one was temporarily disabled when a hit near the rear of the turret ignited crew stowage; another may have been disabled by a shot through the thin armor of the engine compartment, and no hits penetrated the frontal armor. Iraqi T-72 losses have never been tallied with any precision but were probably in the neighborhood of 750–800 tanks; total Iraqi tank losses to all causes was 3,200–3,900 plus 2,400–2,750 of other types of armored vehicles lost. These T-72 losses were not exclusively due to engagements against the M1A1 Abrams tank, but a significant portion were due to direct combat and not air attack.

The Iraqi T-72M1 tanks performed poorly due to technical, tactical, and training problems. On the firepower side, it was incapable of acquiring targets at worthwhile battle ranges especially at night or in poor weather, and its gun/ammunition combination was incapable of penetrating the frontal armor of the Abrams. Better ammunition might have helped on the rare occasions when hits were scored, but the central problem was the lack of hits against the opposing M1A1 tanks. This was the result of both technical and training failures. The T-72's fire controls were too complicated for rapid use by typical Iraqi crewmen. On the defensive side, the T-72's armor was vulnerable to the Abrams 120mm gun, and its unshielded ammunition meant that penetrations usually led to catastrophic fires which incinerated the tank, often too quickly for the crew to escape. These spectacular explosions were profoundly demoralizing to neighboring tank crews, who sometimes abandoned their own tanks after witnessing such frightening conflagrations. On the training side, the Iraqi army was completely unable to operate effectively against a well-trained opponent operating at a much faster battle tempo; tactical success was not within grasp, since the units were chronically unable to conduct ordinary tasks such as establishing a security zone or conducting a reverse-slope defense even when they had the time and resources to conduct them. The popular perception that the Iraqi soldiers simply ran away from the fight was certainly not true of the troops of the RFGC heavy divisions who fought bravely, though ineffectively, during the fierce clashes of February 25–27.



M1A1, 3rd Armored Cavalry Regiment, KTO, 1991. (Artwork by Peter Sarson © Osprey Publishing)

An M1A1HA of 1/64th Armor, 24th Infantry Division (Mechanized), during the victory parade in Washington, DC, on June 8, 1991.

The success of the M1A1 Abrams in the 1991 war was as much about the quality of the crews as the technology; the Marine Corps' old M60A1 tanks performed well, and many US tankers argued that they would have triumphed against the Iraqis even if the equipment had been swapped. While the US Army might have triumphed with older equipment, the superb protection of the M1A1 saved lives. Innovations in the M1A1 design had significant tactical effects, contributing to the fast tempo of operations and the ability to operate day or night even in poor weather conditions. The 120mm gun and the associated fire control system was stunningly lethal, and this was the first war that saw tanks accurately firing on the move on a routine basis.

The Gulf War was also the first war to see the extensive use of thermal imaging sights, and this technology alone was a major factor in the ability of US heavy maneuver battalions to fight 24 hours a day and to stand off and decimate Iraqi units in poor weather during the daytime, when the targets were otherwise not visible. The primary lessons of tank battles in World War II had been that the side that found the enemy first, engaged first, and hit first was most often victorious. The turbine engine, for all of the headaches associated with its prodigious fuel consumption, provided the Abrams battalions with the effortless speed to smash through Iraqi defensive positions before they could react.

A total of 23 Abrams tanks were destroyed or heavily damaged during the conflict, a remarkably low number. Of the nine destroyed Abrams, seven were due to friendly fire, and two were destroyed by their crews after they became disabled to prevent their capture. There is some controversy about the number of Abrams damaged by Iraqi fire and the extent of the damage.

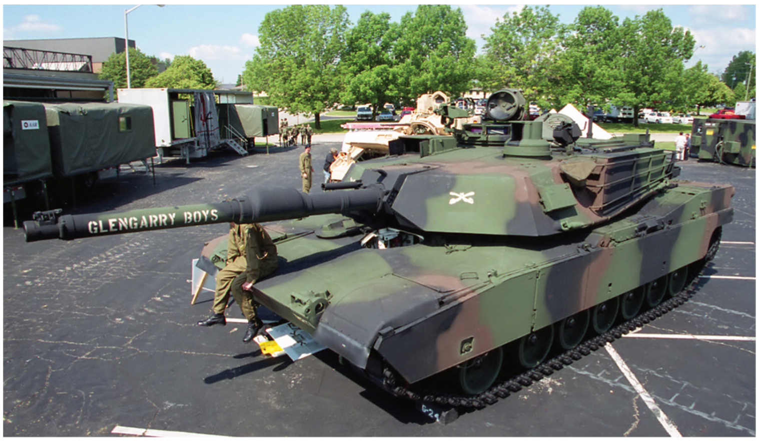
The US government watchdog agency, the Government Accounting Office (GAO), issued a performance assessment of the Abrams tank after the conflict that concluded:

> During the war, the Abrams tank exhibited good reliability, lethality, survivability, and mobility, but limited range… Reported Army readiness rates were 90 percent or higher during the ground war – indicating a high availability to move, shoot, and communicate during combat. The Abrams was lethal, as crews said its 120mm gun was accurate and its ammunition deadly against all forms of Iraqi armor. Army observers attribute the gun's high degree of accuracy to superior sights, high levels of tank readiness, and soldier training. The Abrams also survived well on the battlefield. For example… several M1A1 crews reported receiving direct frontal hits from Iraqi T-72s with minimal damage… Crews said the Abrams tanks were fast and maneuvered well in the sand. Abrams crews were impressed with the power and performance of the Abrams' turbine engine, but they were concerned about its high fuel consumption and the need to frequently clean air filters in the sandy desert environment. Refueling was a constant concern, and faulty fuel pumps further compounded the problem. The harsh desert environment demanded frequent air filter cleaning because sand-clogged filters reduced engine power and speed. In extreme cases, sand damaged engines. Army officials are aware of the problems with high fuel consumption, unreliable fuel pumps, and sand ingestion. They are working on solutions to improve fuel economy, fuel pump design, and the air filtration

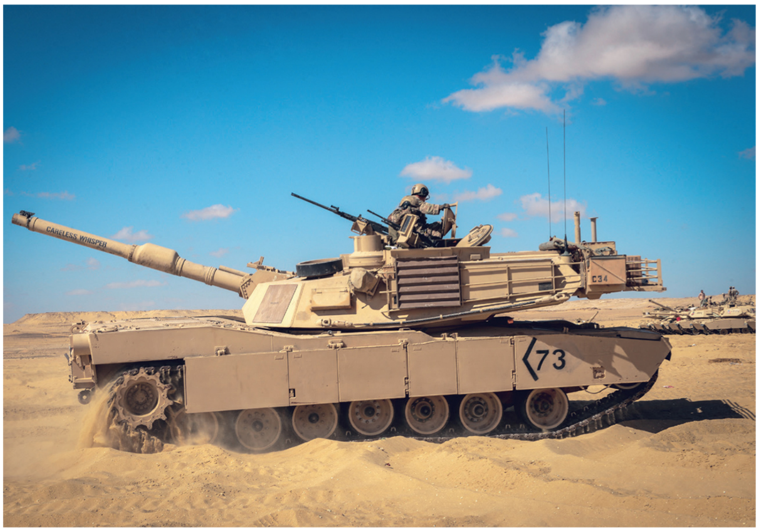
system. Abrams crews also identified other desired tank improvements, including better sight magnification and resolution and the addition of an identification of friend or foe system, a turret/hull reference indicator, and driver's and commander's thermal viewers. Army officials said these and other enhancements were being considered for future Abrams improvements.

M1A2 ABRAMS

The next stage of Abrams tank development was the M1A1E1 Block II. This was intended to incorporate the CITV, an Improved Commander's Weapon Station (ICWS), a position/navigation (PosNav) system, and a digital electronically integrated information system. Full-scale engineering development for a "fiscally constrained" tank was approved by OSD on October 18, 1989, and the contract included the construction of ten prototype and five pilot production tanks. The initial requirement was for 2,926 M1A2 tanks. In April 1990, the Army decided to begin acquisition by completing the last 62 M1A1 tanks funded in FY91 as M1A2 tanks instead of 62 M1A1 tanks. After Congressional permission, this was approved in May 1992. In the event, this would be the only serial production of M1A2 tanks acquired by the Army. The M1A2 was type classified as standard in April 1994.

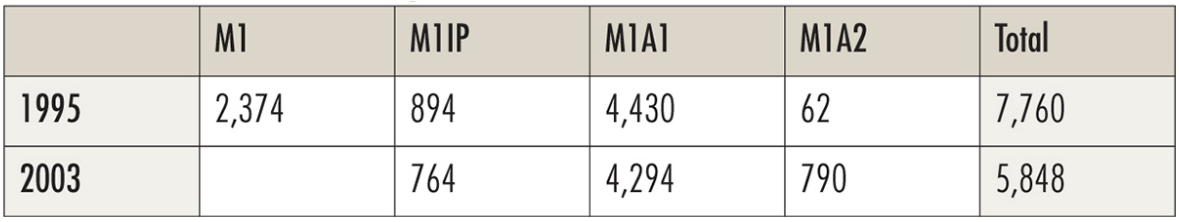


An M1A2 of G Troop, 1/16th Cavalry, at the Fort Knox Armor Center in May 2002, in the standard "Europe 1" camouflage based on the NATO 3 color scheme. The distinctive feature of the M1A2 was the Commander's Independent Thermal Viewer (CITV), located in front of the loader's station on the left front side of the turret. Although not evident from this view, this tank was upgraded to the M1A2 SEP configuration, with the Thermal Management System and Under-Armor APU. (Author)



An M1A2 SEP from the 2/7th Cavalry, 3rd Armored Combat Team, 1st Cavalry Division, participates in a field training exercise during Bright Star 2017, September 15, 2017, at Mohamed Naguib Military Base, Egypt. This tank had the Thermal Management System in the rear bustle, and has some elements from the TUSK kit such as the loader's armor shield. (US Air Force/Staff Sgt. Michael Battles)

M1 Abrams in US Army service



	M1	M1IP	M1A1	M1A2	Total
1995	2,374	894	4,430	62	7,760
2003		764	4,294	790	5,848

US tank production, 1975–2000

	M60A1	M60A3	M1	M1A1	Total
1975	682				682
1976	885				885
1977	981				981
1978	1,179	19			1,198
1979	668	450			1,118
1980	21	786	16		823
1981		523	157		680
1982		349	439		788
1983		382	754		1,136
1984		268	777		1,045
1985		298	594	280	1,172
1986				529	529
1987		94		996	1,090
1988				819	819
1989				725	725
1990				718	718
1991				649	649
1992				480	480
1993				383	383
1994				322	322
1995				346	346
1996				235	235
1997				167	167
1998				120	120
1999				113	113
2000				127	127
Total	4,416	3,169	2,737	7,009	17,331

CHAPTER EIGHT
END OF THE COLD WAR

In the early 1980s, various US Army agencies began focusing on the requirements for the next generation of armored vehicles. There was a growing consensus that instead of developing a separate tank, infantry vehicle, cavalry vehicle, self-propelled gun, and others, it would be better to develop a family of vehicles sharing common components. This was expected to simplify logistics and lower costs.

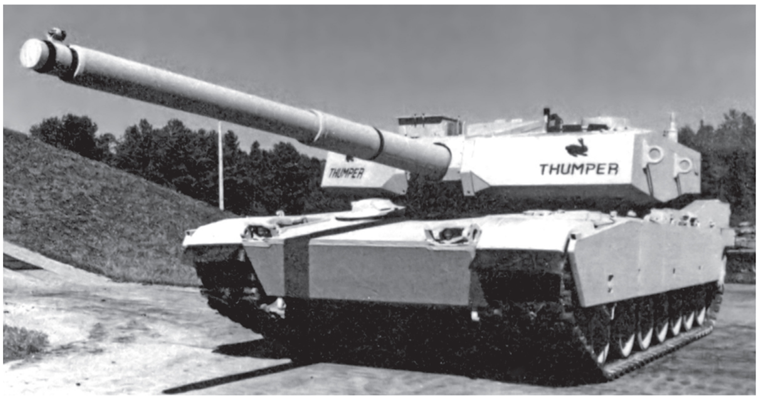
The Special Study Group – Armor in 1983–85 determined that a fleet of armored vehicles based on commonality, modularity, and shared systems was both desirable and feasible. The DSB (Defense Science Board) 1986 Armor/Anti-Armor study concluded that a new modernization effort was required since the US Army was lagging behind the Soviet Army in fielding new systems and that the technology gap was widening. The 1987 DSB study also noted that the Department of Defense was seriously deficient in rapidly transitioning new technology into weapon systems and that this could be addressed by advanced technology demonstrations, similar to the test bed effort of the early 1980s. The Armored Family of Vehicles Task Force in 1986–89 proposed a family of 24 vehicles due to constrained funding. Two further studies in 1988–89 by the DSB and the Department of the Army's Armor/Anti-Armor Task Force reemphasized that the tank technology imbalance was worsening in the Soviet Union's favor and that this imbalance required a major armor modernization effort.

As a result of these studies, in 1990, the US Army initiated its Armored Systems Modernization (ASM) program, estimated to cost a staggering $59 billion for research, development, and procurement. The core of ASM was a family of seven vehicles using common chassis systems. Four of these – the Block III tank, the Combat Mobility Vehicle, the Advanced Field Artillery System, and the Future Infantry

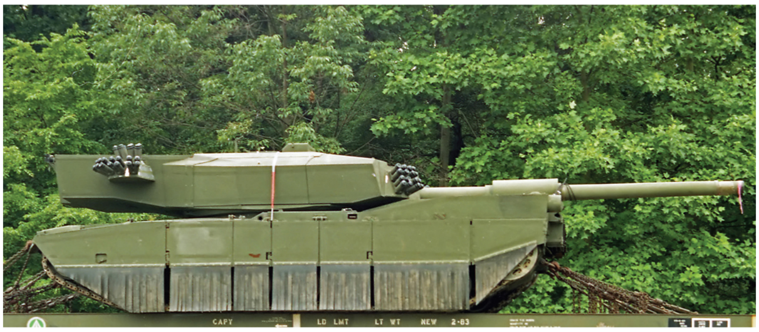
Fighting Vehicle – shared a heavy chassis. Two others – the LOSAT (Line-of-Sight Anti-Tank System) and the Future Armored Resupply Vehicle–Ammunition – would be built on a common medium chassis. The seventh – the AGS (Armored Gun System) – would be developed on a light chassis.

The Army's top priority for the ASM program was the Block III tank, unofficially dubbed the M1A3, with an initial production requirement of 1,946 new tanks. Block III tank production was scheduled to start in the summer of 2001, with the first unit equipped in early 2003.

In view of the DSB recommendations, the Army kicked off the ASM program with the ATACS (Advanced Tank Cannon System) Demonstrator Vehicle, later nicknamed "Thumper." This was basically a modified M1A1 Abrams fitted with a new turret containing the novel 120/140mm XM291 gun fed by the Benét Labs XM91 autoloader. The XM291 was designed so that it could fire the existing family of 120mm tank projectiles. To provide it with growth potential, it could accept a new 140mm gun tube to permit it to fire a next-generation family of 140mm ammunition. The ATACS test bed was delivered to Aberdeen Proving Ground in November 1990, and was mainly intended to test the new gun.



Thumper was the ATACS (Advanced Tank Cannon System) demonstrator vehicle, a modified M1A1 Abrams fitted with a new turret containing the novel 120/140mm XM291 gun.



The CATTB was a test bed for the XM291 gun based on M1 Abrams components but with an enlarged turret to accommodate the new Benét Labs XM91 autoloader. It is seen here with the turret facing to the rear.

In December 1990, the Army awarded contracts to Teledyne Continental Motors and to Armored Vehicle Technologies Associated, a joint venture of General Dynamics Land Systems Division and FMC Corporation for the competitive design and development of a common heavy chassis. As a forerunner to the ASM heavy chassis, the Army funded the CATTB (Components Advanced Technology Test Bed). Besides the XM291 gun and autoloader, it incorporated a more refined turret design that introduced a Rockwell MTAS (Multi-Sensor Target Acquisition System), a millimeter wave radar sensor offering superior range to that of existing tank thermal imaging systems. Propulsion was provided by a Cummins XAP-1000 AIPS (Advanced Integrated Propulsion System) that contained the diesel engine and transmission in an integrated powerpack. The initial CATTB Phase 1 Test Bed was based on an M1A1, but subsequent demonstrators were upgraded with the new features, such as the new engine. The CATTB Phase 3 Test Bed was delivered in early 1993. Based on the CATTB, the Army planned to down-select between the two contractors in 1994 to start engineering development of the Block III tank. However, the ASM program was in serious trouble years before this took place.

Operation *Desert Storm* in January–February 1991 undermined some of the rationale for the ASM program. There had been widespread press criticism of both the M1 Abrams tank and M2 Bradley fighting vehicle prior to *Desert Storm*, views shared by some in Congress. However, the M1A1 Abrams dominated the Iraqi T-72 tank in such a one-sided fashion that many in Congress began to wonder why there was such a rush to replace it with the Block III tank. On top of this, by the summer of 1991, the Warsaw Pact had collapsed, and the Soviet Union appeared to be disintegrating. These two strategic earthquakes suggested that not only was the current Soviet tank threat evaporating, but that a future Soviet tank threat would never emerge.

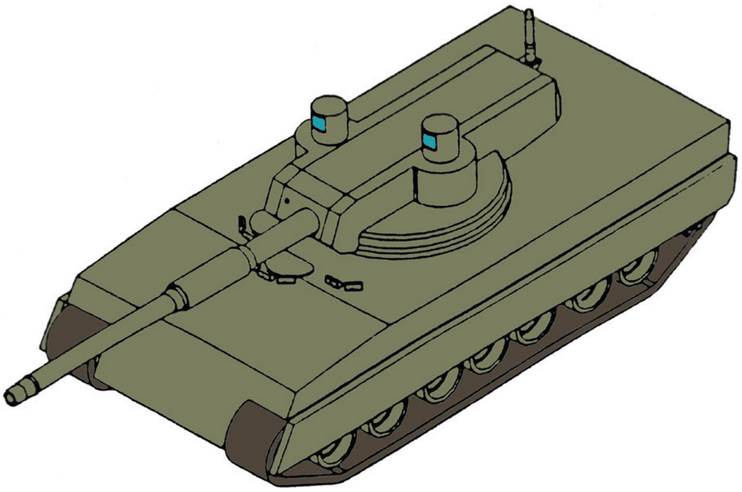
As a result of these revolutionary developments, Congress questioned the Army's priorities for ASM. The Senate favored the Advanced Field Artillery System, intended to replace the old M109 155mm self-propelled howitzer, instead of the Army's favored Block III tank. The Senate zeroed the $113 million research funding request for the Block III tank in FY91. In contrast, the House Armed Services Committee directed the Army to make the Armored Gun System (AGS) its top priority modernization program and in July 1991 cut funding for the Block III tank's 140mm gun program.

In July 1991, the GAO issued its report on the ASM program, raising serious questions about its fiscal soundness. It concluded that the ASM funding would peak between Fiscal Years 1998 and 2007, the same timeframe that funding requirements for the Army's other major modernization efforts were expected to peak. Due to Congressional funding cutbacks, the Army faced a shortfall of $39 billion in 1998–2008. Since the ASM program represented about one-third of the Army's projected funding requirements, significant cutbacks were inevitable. More critically, the GAO noted that the Army had failed to assess how the disintegration of the Soviet Union had undermined the threat assessments at the heart of the ASM program.

The Defense Acquisition Board reviewed the Army's ASM program and directed that the Army develop a more realistic acquisition program. Recognizing the growing disenchantment with the program, in October 1991, the Army agreed to align its ASM strategy with Congress. In December 1991, Army Secretary Michael P. W. Stone proposed delaying the Block III tank, Future Infantry Fighting Vehicle, and Combat Mobility Vehicle in favor of the Advanced Field Artillery System as requested by Congress.

The final collapse of the Soviet Union in December 1991 completely undermined the rationale for the ASM effort, and especially the Block III tank program. In October 1992, the Army recognized the inevitable and canceled the Armored Systems Modernization program. Some elements of the program that were supported by Congress re-emerged, such as the XM2001 Crusader 155mm gun and the XM8 Armored Gun System. But the Block III tank program was dead, and its traces, such as the CATTB demonstrator, were swept under the carpet and disappeared from public view.

On May 20, 1992, Donald Yockey, the Undersecretary of Defense for Acquisition, stated, "There are enough tanks available now to meet any perceived contingency and there is enough time to reconstitute the tank industrial base if a global threat emerges. Therefore, tank production will cease as planned."



The Armored Systems Modernization program was canceled before it reached prototype stage. This is an image of what the Block III tank might have resembled. It bears a strong resemblance to the CATTB prototypes.

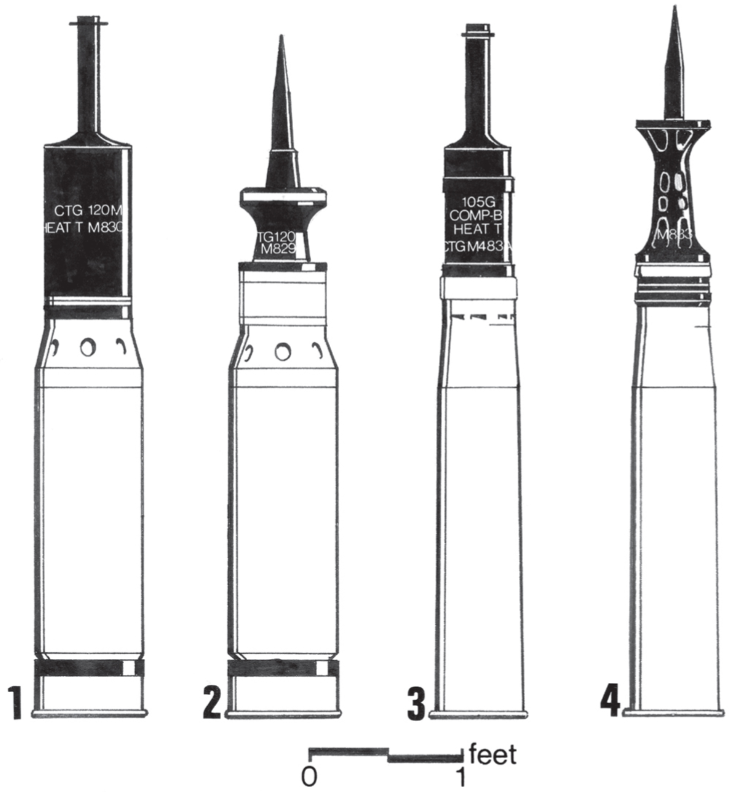
As a result of the OSD decision, no further new tank production for the US Army was funded after FY92, when a final batch of 18 M1A2 tanks were acquired as part of a Gulf War supplemental funding package. The last of the US Army's production series M1A2 tanks were delivered in 1995.

With the end of the Cold War, there was some confusion over the direction that the tank program should take. Congress began to pressure the Army to shift from new M1A2 production to an upgrade/modification program to rebuild older M1 tanks into the M1A2 configuration. This was intended to keep the industrial base warm if it was necessary to restart production. In addition, in July 1990, the US government agreed to sell M1A2 tanks to Saudi Arabia, and there was some interest in keeping at least one factory open for potential export clients. In the event, the Detroit Army Tank Plant ended Abrams production in 1991 so only the Lima Army Tank Plant remained in use.

The Abrams program was reoriented from a new production program to a modification/upgrade program in FY92. These were two distinct, separately funded programs: GA0700 (modification) and GA0750 (upgrade). The modification program was fleet-wide and included a variety of new subsystems that could be incorporated into the M1A1 Abrams without the need for a complete reconstruction of the tank. The upgrade program focused on the deeper modernization of older M1 and IPM1 tanks to the M1A2 configuration since these tanks were regarded as obsolete due to their 105mm guns and older armor packages. These programs were conducted primarily at the Lima Army Tank Plant in conjunction with the Anniston Army Depot.

M1A1 MODIFICATION PROGRAM 1990–2000

The M1A1 modification program began in 1989 even before M1A1 production had ended. The first major effort was the Armament Enhancement Initiative (AEI), which developed new types of 120mm tank gun ammunition. This included the M829A1 APFSDS round, better known as the “Silver Bullet” for its performance in Operation *Desert Storm*. Another new cartridge was the M830A1 HEAT-MP-T. This was a replacement for the older M830 HEAT cartridge, but it used an entirely reconfigured sub-caliber projectile with discarding sabot to increase its speed. The other novel feature was the incorporation of an optional anti-helicopter mode, hence the designation “MP” for multi-purpose. If engaging a helicopter, the loader could activate the proximity sensor in the nose of the projectile. As a result, the projectile could engage helicopters at extended ranges without needing to score a direct hit. This cartridge was type classified after *Desert Storm* in September 1992 and was widely deployed by 1994.

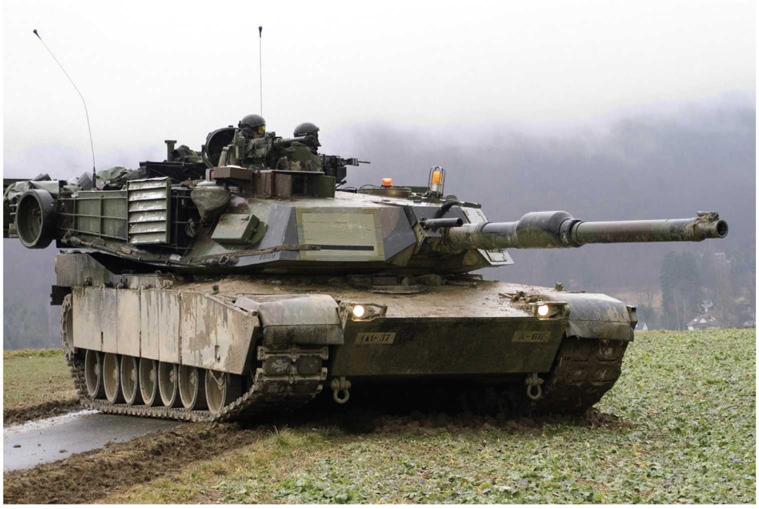


US tank gun ammunition, left to right:
(1) 120mm M830 HEAT-T;
(2) 120mm M829 APFSDS-T;
(3) 105mm M483A1 HEAT-T;
(4) 105mm M833 APFSDS-T.
(Author)

Although most of the AEI program focused on the ammunition, it also required improvements on the M1A1 Abrams, such as adjustments in the tank fire control system to accommodate the ballistics of the new ammunition types as well as the addition of new reticles in the sighting system. This was a continuing modification effort since several generations of new ammunition were introduced through the 1990s. Rock Island Arsenal also upgraded the first 1,630 M1A1 tanks with gun mount improvements to accommodate the higher pressures of the new ammunition. In 2004, a program began to modify tanks to use the newer M829A3 “Super Sabot” round.

One of the high-priority efforts after Operation *Desert Storm* was the pulse-jet system (PJS) that replaced a large portion of the previous engine air filtration system. This helped extend the time between required air path servicing in severe dust environments such as the desert. These upgrades began in 1995 and were mostly completed by 2008.

In 1999, the US Army tested a longer version of the German 120mm with a tube length of L/55 that was being developed for the Leopard 2A5 tank. The longer 120mm M256E1 was tested on an M1A1, but there were no further plans for production since it was felt that the existing gun and new ammunition were sufficient.



An M1A1 AIM of 37th Armor, 1st Armored Division, during Exercise Ready Crucible in Germany, on February 11, 2005. This shows the usual configuration of the Combat Identification Panels (CIPs) in use since Operation *Desert Storm*, with the venetian style on the sides and the flat panels on the front. One side of the panel is a low-emissivity thermal coating, and on the other side is the usual green or tan CARC paint. This tank has the panels in the “off” position, with the CARC paint side exposed; the other side creates a distinct signature when viewed through thermal imaging sights. (DoD/Richard Bumgardner)

Many of the improvements on the M1A1 exploited the growing capabilities of modern electronics. In 1999, the M1A1 was improved by the introduction of a Precision Lightweight GPS Receiver (PLGR). This was based on the lessons learned from Operation *Desert Storm*, where the improvised use of hand-held GPS receivers was shown to be a revolutionary leap forward in vehicle navigation. This program continued through 2008, with about 1,325 tanks fitted with the PLGR.

In 1992, the Army started the M1A1-D (GA0720 digitization) program. This modification was part of a broader Army digitization effort called Force XXI Battle Command Brigade and Below (FBCB2). One of the novel capabilities it offered was a pointing device incorporated into the tank's computer to provide range and elevation data necessary to engage targets beyond the crew's line of sight. This program was funded in FY01–FY02 to equip 1,535 M1A1 tanks.

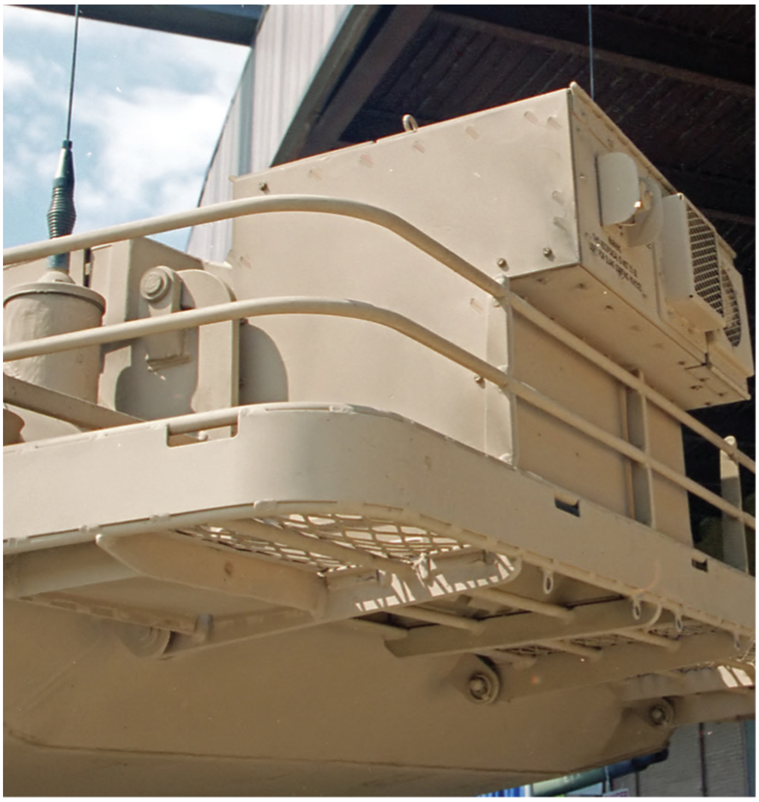
The first step in addressing the problem of friendly fire incidents was the development of a simple Combat Identification Panel (CIP) that could be carried on tanks. This has a distinctive signature when viewed through a thermal imaging tank sight. The next step was to take advantage of digital innovations. Blue Force Tracking (BFT) is a digital system that gives Army commanders across the battlefield current information about their location relative to friendly forces. Once the M1A1 was fitted with the PLGR, the GPS navigation/location data could be fed into the FBCB2 computer system. This emits a signal that is integrated into the BFT map display showing the precise location of all other friendly forces equipped with BFT. The BFT was installed on M1A1 tanks starting in 2005. In 2013, this was followed by BFT-2, which uses modernized transceivers to improve the speed and "refresh" time of the network. BFT-2 is part of a larger program called Joint Battle Command-Platform (JBC-P) that adds next-generation mapping, chat and messaging capability, and an improved graphical interface as well as expanding the network to include a wider range of BFT devices with infantry, armor, and other combat units.

The growing use of electronics on tanks also created increased electrical power demands. After much debate, in 1991–94 the Army added External Auxiliary Power Units (EAPUs) to 1,500 M1A1 tanks to avoid the need to run the main gas-turbine engine for electrical power when in stationary Silent Watch Mode. The EAPU provides power for ten to 12 hours on one tank of diesel fuel. The Army decided to wait for an Under-Armor APU (UUAPU) for the new M1A2 SEP. Congress disagreed and funded a short-term modification effort. As a result, in 1997, 336 M1A2 tanks had EAPUs mounted in the left side of the turret bustle rack.

In 1998, a program was begun to incorporate improved turret side armor into the M1A2. This was intended to offer better protection against rocket-propelled grenades more modern than the baseline RPG-7. These kits were installed on about 325 older M1A2 tanks in 2001–09 and were also included in upgraded tanks.

In 1999, a program began to replace the existing laser rangefinders with eye-safe laser rangefinders (ELRFs). This was done because stringent safety precautions had to be taken during peacetime training with the older lasers since they could cause eye damage. About 3,200 M1A1 and M1A2 tanks were modified with this device though 2009.

By the late 1990s, portions of the M1A1 fleet were becoming mechanically exhausted, leading to increased maintenance costs. The Abrams Integrated Management for the 21st Century (AIM XXI) program was initiated to deal with tanks that were not earmarked for the M1A2 upgrade. The M1A1 tanks were completely disassembled at the Anniston Army Depot and then overhauled by GDLS at the Lima Army Tank Plant. The first of the M1A1 (AIM) tanks were delivered in July 2000, and by 2004 about 135 tanks went through the AIM process annually. Once the program was underway, the AIM program became the venue for the various modifications underway for the M1A1 force.



In the early 1990s, the Army began installing External Auxiliary Power Units in the rear bustle rack on the M1A1 tank. These were used to power the tank when in Silent Watch Mode with the main engine turned off to conserve fuel. This is an example on an M1A1 AIM. (Author)

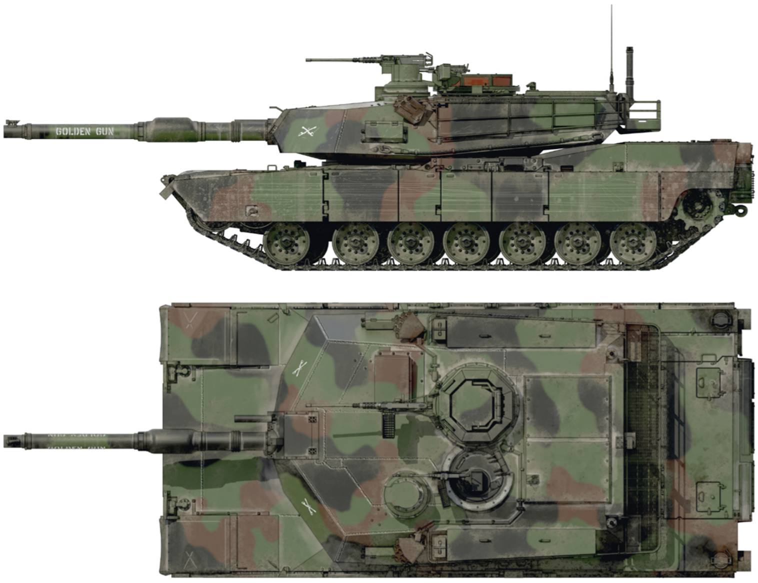
M1A2 UPGRADE PROGRAM

The decision to halt further new Abrams tank production, plus the availability of a large pool of older M1 and IPM1 tanks, led the OSD on December 18, 1992 to approve a program to upgrade 998 M1 tanks into the M1A2 configuration starting in 1993. The first upgraded M1A2 was delivered in October 1994 and the first unit equipped was the 3rd Squadron, 8th Cavalry, at Fort Hood, Texas. The upgraded tanks received the CITV, Improved Commander's Weapon Station, position/navigation equipment, improved armor, and other features.

While the basic upgrade process was underway, the Army also began the first steps toward a System Enhancement Program (SEP) aimed at the M1A2 fleet. The main focus of this program was to improve the computer core of the M1A2 so that it could be employed in an all-digital division. The SEP included the improved FBCB2 digital command and control system, second-generation "Block 0" thermal imaging systems, a computer memory upgrade, color map displays, and other features. The second-generation HTI-SGF thermal imaging system replaced the existing sensors in the Gunner's Primary Sight and Commander's Independent Thermal Viewer with new-generation technology that offered substantially better image quality. This entered production in the baseline "Block 0" configuration in 1997 and first entered service in 1999.

As mentioned above, the M1A2 SEP upgrade was intended to incorporate an Under-Armor APU (UUAPU), located in the upper left corner of the rear engine compartment, replacing the previous 55-gallon fuel cell. One of the reasons for locating the UUAPU in the hull was the need to find space for the Thermal Management System (TMS) which was added to the M1A2 SEP. The TMS Model 3212, provided by Meggitt Defense Systems, was designed to remove excess heat produced by the increasing volume of electronics in the turret. The most visible element of the TMS was a Vapor Compression System Unit (VCSU) that was mounted on the left turret rear in the turret bustle where the EAPU had previously been located. In the event, the UUAPU for the M1A2 SEP proved to be unreliable, and it was replaced after 2005 with the battery-based Alternate APU (AAPU). The new Hawker batteries employed absorbed-glass-mat (AGM) battery technology instead of the older flooded-cell lead-acid technology.

The first M1A2 SEP was delivered in September 1999, and the first unit equipped was a company in the 4th Infantry Division (Mechanized) at Fort Hood in May 2000. The M1A2 SEP was also deployed with the 1st Cavalry Division. The M1A2 SEP program was later extended by a separately funded program, GA0730, to retrofit the existing fleet of M1A2 tanks to the M1A2 SEP standards, with funding from FY01 to FY09 for 319 upgraded M1A2 tanks.



M1A2 Abrams, 1/16th Cavalry, Fort Knox, Kentucky, 2002. (Artwork by Felipe Rodríguez © Osprey Publishing)

In September 2000, the Army awarded a team of General Electric and Honeywell to develop their LV-100-5 gas-turbine engine as the Abrams-Crusader Common Engine (ACCE). The plan was to use this more modern engine to replace the older AGT-1500 in the Abrams, as well as to power the new XM2001 Crusader 155mm self-propelled gun. In the event, the cancelation of the Crusader program in May 2002 put an end to the new engine program. In its place, the Army initiated the TIGER (Total Integrated Engine Revitalization) program, which aimed to completely rebuild the existing engines to the equivalent of brand-new engines. At the IDEF-97 show in Ankara in 1997, GDLS offered the Turkish army a version of the M1A2 using the German EuroPowerPack diesel engine. In the event, Turkey selected the Leopard II tank.

THE EXPEDITIONARY TANK

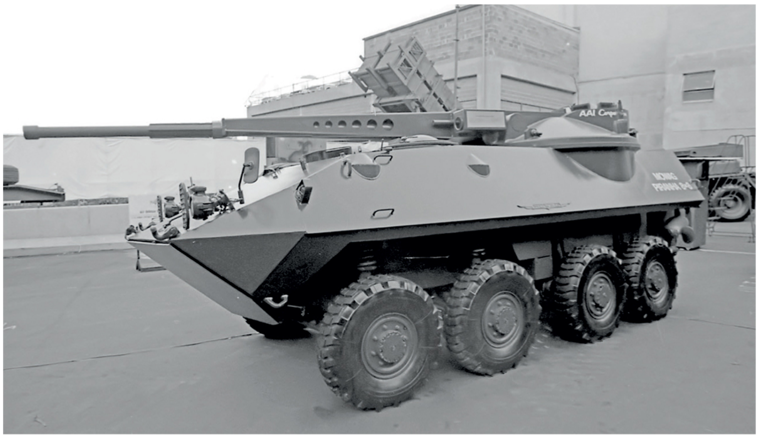
The US Army embarked on a four-decade quest to replace the M551 Sheridan in the late 1970s. The program was continually delayed more by conflicting doctrinal requirements and budget issues than by technology. This effort was sometimes a cooperative effort with the US Marine Corps.

The Iran hostage crisis in 1979 convinced the US military that it had become overly focused on the NATO–Warsaw Pact confrontation to the detriment of its ability to deal with regional crises outside of central Europe. This led to the creation of the Rapid Deployment Force (RDF) in 1980, a multi-service command intended to facilitate rapid intervention missions around the globe.

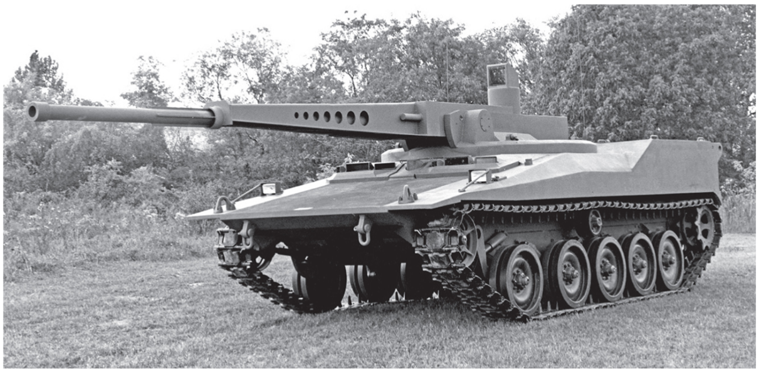
Many scenarios suggested the need for armored support. Existing tanks like the M60A1 or M1 Abrams could be delivered only by airlift and required the use of scarce C-5A transport aircraft. A lighter tank seemed like a natural element for the RDF. The Marine Corps requirement was called the Mobile Protected Weapon System (MPWS), while the Army requirement was dubbed the Mobile Protected Gun (MPG).

The Marine Corps divided its MPWS program into near-term, hybrid, and conceptual. The MPWS near-term requirement began in April 1981 as a competitive effort to field a wheeled infantry vehicle armed with a 25mm Bushmaster automatic cannon. The GM-Canada Piranha, built under license from the Swiss Mowag firm, was selected later in September 1982 and became the Light Armored Vehicle (LAV). The Marines considered adapting the existing 105mm tank gun to the surplus Sheridan fleet, and a Sheridan was rebuilt by the Naval Surface Weapons Center Lab in Dahlgren, Virginia, in 1983 to test the concept. The program never received enough support to reach the production stage.

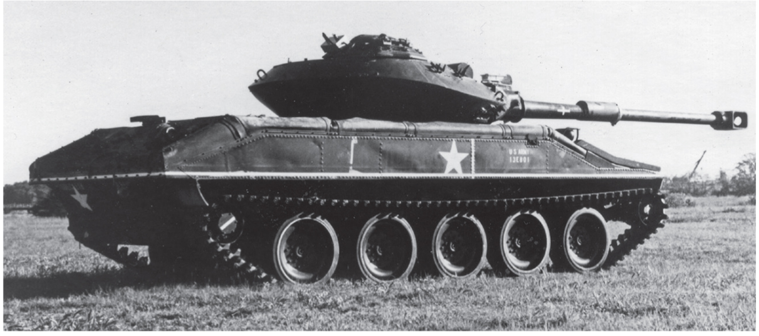
The Marines began examining a possible MPWS-hybrid and conceptual in May 1981 and issued contracts to nine firms in May 1981. Three hybrid contracts were awarded. Britain's Alvis offered a Scorpion light tank with Cockerill 90mm gun. Cadillac Gage offered its V-300 light armored vehicle with Cockerill 90mm gun, and GM-Canada offered a version of the LAV/Piranha with the AAI/Ares turret with 75mm Ares XM274 Delta-3 automatic cannon. Seven conceptual contracts were awarded, of which only one, to AAI, resulted in an actual prototype. AAI used its experience with the HSTV-L to build the RDF light tank. This was equipped with a 75mm Ares XM274 gun, but fitted with a Detroit Diesel 6V53T engine instead of the gas-turbine used in the HSTV-L. This was first displayed at the annual Association of the US Army convention in Washington, DC, in October 1981.



One of the contenders for the Marine Corps' LAV-AG was this entry that combined the Mowag Piranha with a 75mm Ares XM274 gun turret derived from the AAI RDF light tank program. (Author)



The AAI RDF light tank was one of the contenders for the Marine Corps' MPWS in the early 1980s. It was armed with a 75mm Ares XM274 gun with autoloader, permitting it to use only two crewmen. This tank was an evolution of the earlier AAI light tanks, including the T92 and HSTV-L.



The Navy Surface Weapons Center adapted the standard NATO 105mm gun to the Sheridan as a contender for the MPWS requirement in 1983.

The Marine MPWS eventually evolved into the LAV-AG (Assault Gun), a version of the LAV with a 105mm gun. In June 1990, the USMC selected Cadillac Gage Textron to develop the 105mm gun turret armed with the low-recoil EX-35 gun for delivery in May 1992. Testing revealed that the recoil from the gun was excessive for the chassis and the program was terminated. Later in the 1990s, the "remedial" LAV-AG was proposed, but armed with a Cockerill turret with the Mecar KEnerga 90mm gun. Even this smaller gun was excessive for the chassis and the LAV-AG program ended.

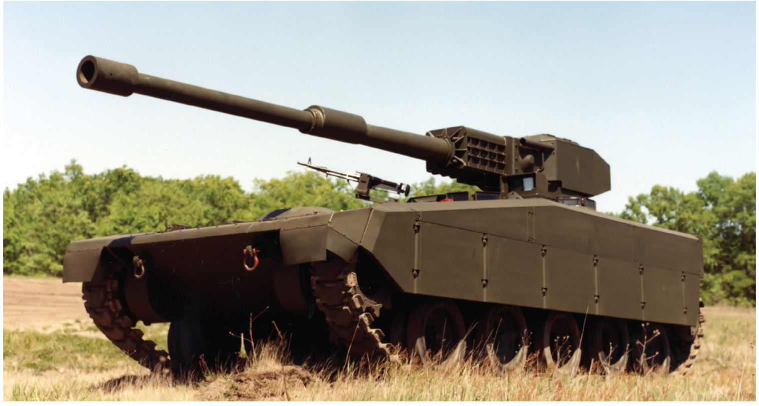
The Army conducted an MPG study in 1980 to examine potential candidates that could be readily created using available vehicles. This included an M551 Sheridan armed with a 105mm gun, an M41 light tank armed with a 90mm gun, and a turreted version of the M113 APC. In December 1984, the Army announced plans to ship 41 Sheridan tanks to the experimental 9th Light Division and eventually modify a further 120 Sheridans with 105mm or 120mm guns. This program was very short-lived and canceled in April 1985 after a study concluded that the Army lacked sufficient spare parts and that the cost would be too high to win Congressional support.

The Army bifurcated the MPG requirement into MPG-N (Near-Term) and MPG-FT (Far-Term). The Army concluded that the best near-term alternative would be the Marine Corps LAV supplemented by HMMWV light trucks armed with the TOW anti-tank guided missile launcher. The joint MPWS/MPG effort was renamed as the Mobile

Protected Gun System (MPGS), but the Army withdrew from the LAV program in December 1983.

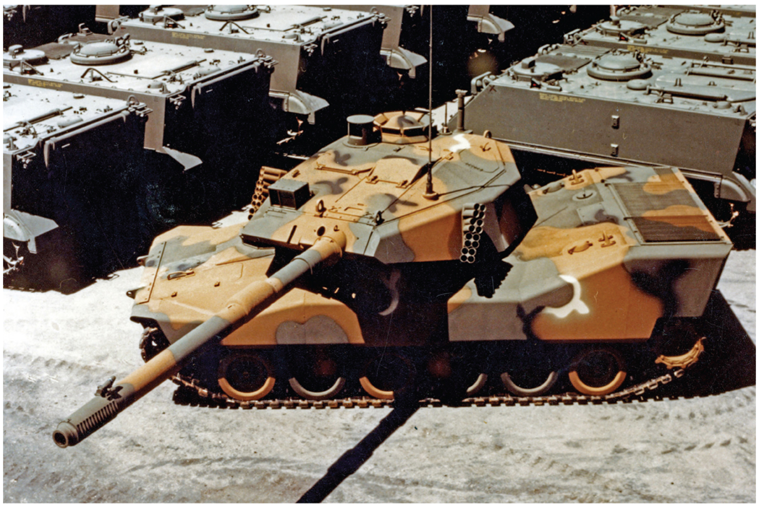
The LAV received the Army designation M1047. Fourteen of these were tested by the 82nd Airborne Division at Fort Bragg, including parachute tests and LAPES delivery, starting in 1987. Although very useful as scout vehicles, they did not have enough firepower to replace the Sheridan and they were a bit top-heavy for LAPES. Eleven Army M1047 LAVs were deployed as a scout platoon of 3/73rd Armor, 82nd Airborne Division, during Operation *Desert Storm* in 1990–91.

The MPG-FT was envisioned as a light tank that could be available later in the decade. The program was renamed in 1983 as the XM4 Armored Gun System (AGS). The program suffered considerable delay due to budget problems and confusion over the technical requirements. The original objective was for about 600 tanks for the 82nd Airborne Division, 2nd Armored Cavalry Regiment, and several other units. The program had little priority, and in 1985, the Senate cut funding for the AGS program from the FY86 budget. In May 1986, the AGS program was reorganized as part of the Armored Family of Vehicles Task Force and subsequently named the Armored Support Platform. Congress was not especially happy about the program and recommended an off-the-shelf purchase. This attitude changed after the successful use of the Sheridans of the 3/73rd Armor in Panama as part of Operation *Just Cause* in December 1989, which highlighted the value of airborne tanks.

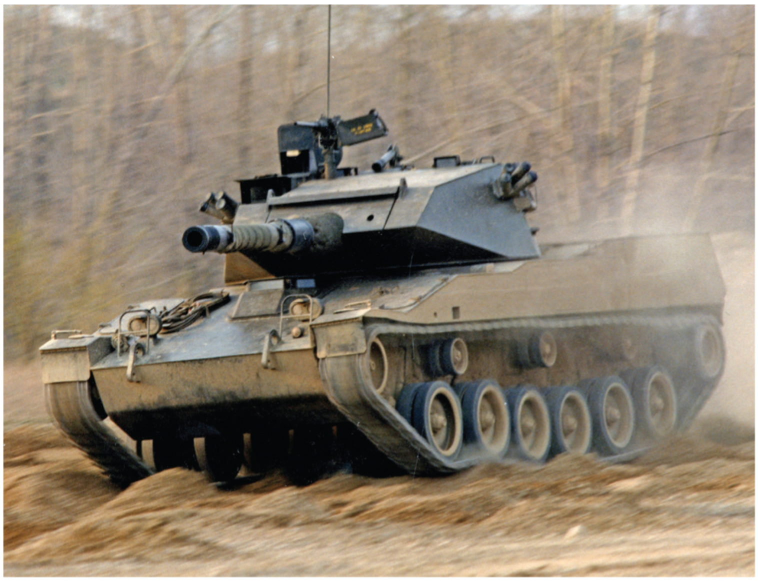


The Teledyne Continental contender for the Armored Gun System was the TCM-20 light tank. Although it lost to the FMC design, the Overhead Gun Mount later evolved into the weapon system used on the Stryker MGS.

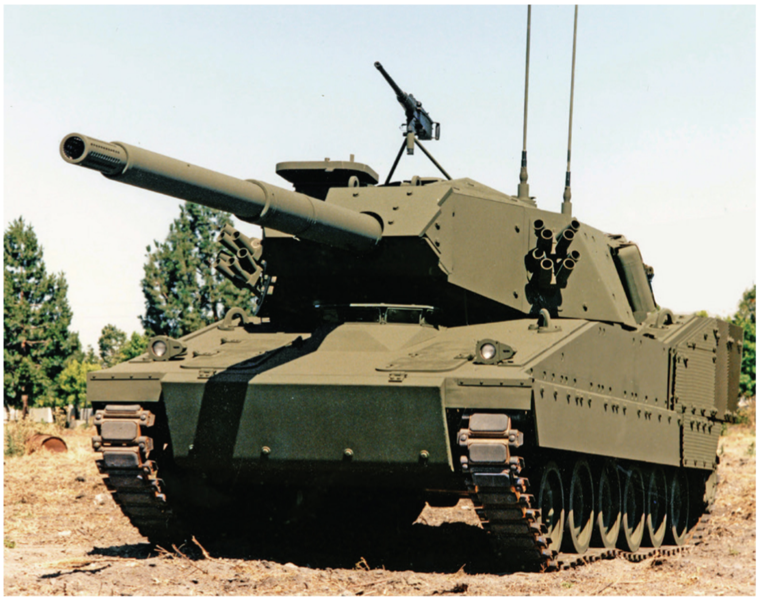
Formal requirements for the revived AGS were finally issued in April 1990 as part of the Army's ambitious Armored System Modernization program. The Marine Corps showed some interest in the program due to the failure of its own LAV-AG program, referring to its requirement as the Expeditionary (Light) Tank. The request to industry was released in 1991, and four companies submitted bids: FMC Corporation, with its Close Combat Vehicle Light (CCVL); General Dynamics teamed with Teledyne Continental Motors, offering their TCM-20 AGS light tank; Cadillac Gage Textron, offering the Commando Stingray with the LAV-105 turret; and Team Hägglunds USA, with a variant of the Swedish CV 90 with a French GIAT turret. The program received further impetus from the House Armed Services Committee in 1991 that recommended the Army switch priority in its Armored System Modernization program from the Block III tank to the AGS.



The Close Combat Vehicle Light was FMC Corporation's contender for the Army's Armored Gun System competition. The turret underwent significant redesign before it became the M8 Buford AGS.



The Stingray light tank was developed as a private venture by Cadillac Gage Textron for the international export market. Its main attraction over surplus M41 tanks was its 105mm main armament. Its sole export success was to the Royal Thai Army in 1988, which purchased 106 tanks. It was a competitor in various US Army light tank programs, including the Armored Gun System, in some cases with a different turret.



Development of the Armored Gun System light tank began in the early 1980s as a replacement for the M551 Sheridan. The FMC design was armed with a 105mm gun and weighed about 37 tons. The AGS eventually emerged as the M8 Buford, seen here with the Level 1 protection package, capable of being air-dropped.

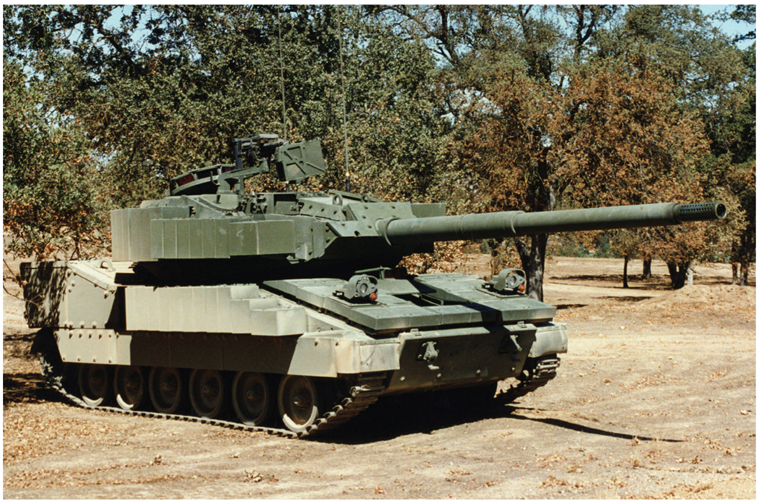
The requirement for air-drop capability was eliminated in March 1991, with the Army settling on LAPES delivery as had been the case with the Sheridan. Congress tried to force the Army to buy the Marine Corps' wheeled LAV-105. This ended abruptly when the Marines canceled the LAV-105.

The FMC Corporation Close Combat Vehicle Light (CCVL) design was selected in June 1992 as the XM8 AGS. Six prototypes were built by United Defense, the name of the new firm created by the merger of FMC's defense division with BMY.

To minimize weight and size, the AGS used a two-man turret crew and autoloader. In its basic "Level 1" configuration, the design was intended to provide armor against heavy machine-gun fire while being light enough to be air-dropped; Level 2 and Level 3 added progressively greater levels of appliqué armor to offer better protection against common battlefield threats, such as the ubiquitous RPG, and could be delivered either by the C-130 (Level 2) or C-17 (Level 3). The idea behind this was that the AGS could be deployed by air in its light, Level 1 configuration, and the appliqué armor shipped separately if needed and mounted in theater; the vehicle weighed between 19 and 25 tons in combat-loaded configuration depending on the armor package. This provided the Army with a more versatile vehicle that could have heavier armor when needed, and greater portability for scenarios where the anti-armor threat was not as great.

The XM8 was powered by a Detroit Diesel 6V92TIA with a Lockheed-Martin HMPT 500-3EC transmission. It had a road speed of 45mph and a range of 280 miles. The main gun was the M35 soft-recoil 105mm gun stabilized in two axes with a co-axial 7.62mm M240.

The first XM8 was completed in April 1994 and delivered to Fort Knox, Kentucky, in April 1995. The final prototype was delivered in May 1995. The new tank was standardized as the M8 in October 1995, and tentatively designated as the Buford after Civil War cavalry general John Buford. The initial plan was to acquire 237 tanks in 1997–2004 for the 3/73rd Armor, 82nd Division, the 2nd Armored Cavalry Regiment, and various other units. The objective was subsequently trimmed back to 68 tanks to be funded in FY96 and FY97 with a unit cost of about $4.7 million each.



The M8 Buford AGS could incorporate several add-on armor packages to improve its survivability. This is the Level 2 package with an explosive reactive armor appliqué.

The program lasted only a few more months before being canceled by Army Chief of Staff Gen. Dennis Reimer in January 1996. Shortfalls in the Army's FY96 budget led to the decision to cut whole programs rather than to spread out the cuts, and the AGS fell victim to this decision. The cancelation was done without Congressional support and was controversial at the time in view of the funds spent to date.

The M8 was subsequently used as a demonstrator for the XM291 120mm gun, dubbed the Thunderbolt. United Defense Corporation in 2003 displayed the Thunderbolt at an Association of the US Army convention as a possible contender for the Future Combat Systems requirement, but this failed to win any support.

Lacking the new M8 AGS and forced to retire the M551 Sheridan due to age, on September 11, 1996, the Army announced plans to inactivate its only airmobile tank unit, the 3/73rd Armor, at Fort Bragg, North Carolina. Although the M551A2 VISMOD Sheridans continued to serve at the NTC until 2004, this marked an end to the combat career of the M551 Sheridan. For contingency operations, an IRC (immediate ready company) from the 3rd Infantry Division at Fort Stewart, Georgia, equipped with M1A1 Abrams tanks and Bradley fighting vehicles, was assigned to augment the 82nd Airborne Division when armored support was needed, with plans to airlift them to combat using the new C-17 transport aircraft.

The shortsighted cancelation of the M8 AGS left a gap in Army capabilities for rapid intervention missions. The Army was forced to restart a similar program three decades later as the Mobile Protected Firepower vehicle.

Comparative technical data of expeditionary tanks

Designation	**M41A2**	**M551A1**	**M8**	**M10**
Name	Walker Bulldog	Sheridan	Buford	Booker
Crew	4	4	3	4
Loaded weight (tons)	25.6	16.8	19.4	42
Length overall (in)	320	248	361	375
Width (in)	126	110	104	135
Height (in)	119	116	100	130
Main gun type	M32	M81E1	M35	M35

Gun caliber (mm)	76	152	105	105
Elevation (degrees)	-10 +20	-8 +20	-10 +20	-10 +20
Rounds stowed	57	9 msl + 20	30	
Co-axial MG (mm)	7.62	7.62	7.62	7.62
Engine	AOSI-895-5	GM 6V53T	6V92TA	MTU 8V 199
Engine type	gas	diesel	diesel	diesel
Horsepower	500	300	550	805
Transmission	CD-500-3	XTG-250-1A	HMPT 500-3EC	Allison 3040 MX
Road speed (mph)	45	43	45	40
Max. range (mi)	110	350	300	190
Fuel (gal)	140	158	150	

CHAPTER NINE

THE NEW WORLD DISORDER

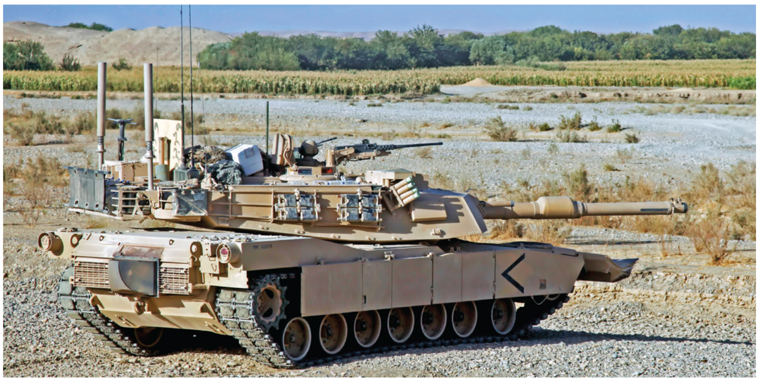
At the time of the Second Gulf War in 2003, the active US Army Abrams fleet numbered about 2,340 Abrams tanks, with about 1,510 tanks deployed with armor battalions and cavalry squadrons and 700 more in pre-positioned stocks around the globe. There were also over 3,000 Abrams tanks in storage. Of the divisions assigned to the Counter Attack Corps, the 1st Cavalry Division and 4th Infantry Division were converting to the M1A2 SEP, the 3rd Armored Cavalry to the M1A1 AIM, and the 3rd Infantry Division to the M1A1.

A pair of M1A1 AIM tanks of Co. A, 1/35th Armor, 2nd BCT, 1st Armored Division, pose under the Hands of Victory monument in Ceremony Square, Baghdad, during Operation *Iraqi Freedom* on November 13, 2003. (USAF/TSgt. John Houghton Jr.)

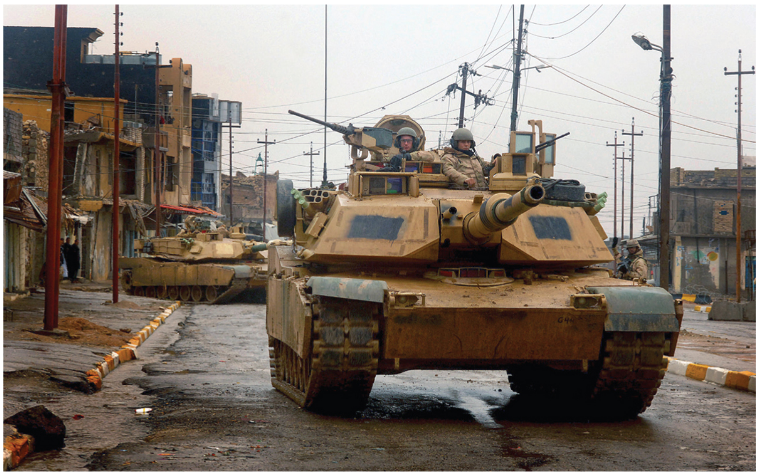
A Marine Corps M1A1 Abrams of the Marine 2nd Tank Battalion fires its main gun into a building to provide suppressive counterfire against insurgents during a firefight in Fallujah, Al Anbar Province, Iraq, on December 10, 2004. This tank is fitted with one of the USMC Bustle Rack Extensions on the rear of the turret. (US Marine Corps/Lance Corporal James J. Vooris)

Operation *Iraqi Freedom* (OIF) began on March 19, 2003, and was aimed at overthrowing the Baathist regime of Saddam Hussein. The ground portion of the conflict was spearheaded by the US Army V Corps, with the 3rd Infantry Division as its primary mechanized force. The 3rd Infantry Division had 247 M1A1 Abrams tanks at the start of the conflict. While this force advanced on Baghdad from Kuwait, the 1st Marine Expeditionary Force advanced on its right flank, including two tank battalions with 116 M1A1 tanks. The 4th Infantry Division, equipped with the newer M1A2 SEP tanks, was intended to operate from Turkey against northern Iraq, but in the event, permission was refused by the Turkish government. It eventually moved into Iraq after the initial attack. The Iraqi army had not been significantly reconstituted since Operation *Desert Storm*, and the campaign was concluded in a month and a half by early May 2003. Several Abrams tanks were destroyed or damaged during the campaign, primarily by infantry anti-tank weapons and not Iraqi tanks.

In contrast to the first Gulf War, the US Army remained on occupation duty in Iraq subsequent to the conflict. Instead of a conventional conflict, the situation gradually deteriorated into a violent civil war and insurgency. Tanks were not a central feature of US Army counter-insurgency doctrine, but Abrams tanks remained in Iraq and were used in a variety of missions in support of counter-insurgency operations. By early 2005, about 80 Abrams tanks had been damaged, primarily due to mine, IED, and rocket attacks, and were sent back to the United States for repair. As of 2009, there were about 410 Abrams deployed in Iraq.



An M1A1 tank of Delta Company, 2nd Marine Tank Battalion, during an operation in Helmand Province, Afghanistan, September 7, 2013. The exhaust plenum for the Deep Water Fording Kit peculiar to Marine tanks can be seen in the center of the rear exhaust grill. The two cylindrical antennas are associated with the AN/VLQ-12 CREW (Counter Remote Controlled Improvised Explosive Device (RCIED) Electronic Warfare) system. (US Marine Corps/Cpl. Trent A. Randolph)



A combat patrol of M1A2 tanks of the 3rd Armored Cavalry Regiment in Tal Afar, Iraq, on February 3, 2005. This tank is fitted with the Loader's Armor Gun Shield (LAGS) but not the full TUSK kit. (US DoD/Staff Sgt. Aaron Allmon, USAF)

The counter-insurgency campaign led to an urgent requirement for an anti-personnel projectile for the 120mm gun. General Dynamics developed the M1028 canister round on a crash basis. This projectile contains 1,000 tungsten balls that spray out in a wide arc. The projectile was also designed so that it could carry less lethal payloads as an alternative, such as rubber balls or "flash-bang" stun charges. This cartridge was type classified in December 2004. Although developed prior to the Iraq campaign, the M908 120mm obstacle reduction round saw its combat debut there. This was a high-explosive round specifically designed to attack bunkers or concrete obstacles.

There were a number of other improvements added to the Abrams during the course of the fighting. One visible change was the development of a Bustle Rack Extension (BRE) by the Marine Corps. This was necessary in part since the original bustle rack was gradually fitted with permanent equipment such as the External APU, limiting the amount of exterior stowage.

One of the emerging threats from the insurgent forces was the use of remotely detonated roadside bombs, usually categorized as IEDs (improvised explosive devices). These varied in size from small anti-personnel mines through massive road mines based on artillery projectiles and even aircraft bombs. To address the IED threat, there were several modification programs for the Abrams fleet. One approach was the development of IED jammers. Many of the IEDs were remotely detonated using radio-based devices such as garage door openers. Jammers were developed that could detonate the IED away from US troops, or jam the frequency to prevent detonation. This program was not unique to the Abrams tank effort but part of a broader effort. One of the more common types fitted to the Abrams was the AN/VLQ-12 Duke system.

The most elaborate effort was TUSK (Tank Urban Survivability Kit). This was designed to address several threats encountered in Iraq. GDLS was awarded a contract for the first batch of 505 TUSK kits in August 2006, with further kits purchased in later years. The TUSK upgrade was an appliqué that could be attached to any of the current versions of the M1A1 and M1A2.

Although the Abrams frontal armor was largely proofed against insurgent rocket-propelled grenades (RPGs), the sides were more vulnerable. A new threat appeared in the form of an off-route mine developed in Iran that used an EFP (explosively formed penetrator) warhead. To address this threat, the TUSK included a set of ARAT (Abrams Reactive Armor Tiles). The basic ARAT 1 kit consisted of 32 XM19 boxes on each side of the tank. The more elaborate TUSK II configuration added the XM32 ARAT II tiles. These are rounded panels, and 32 are attached over the XM19 boxes on the hull sides as well as 11 more attached to the turret sides. These explosive reactive armor tiles added over 3 tons to the tank's overall weight and so were generally not fitted to tanks unless in a war zone. To deal with the mine threat, TUSK also included a 2-ton belly armor kit which attached under the crew compartment. Vehicle seats were also modified to reduce crew injuries during IED explosions by providing shock-absorption features.

Abrams' loaders operating the external M240 machine gun were vulnerable to snipers, so a Loader's Armor Gun Shield (LAGS) was added that offers ballistic protection while at the same time offering forward vision through a Transparent Armor Gun Shield (TAGS). The loader was also provided with a Loader's Thermal Weapon Sight (LTWS) for night vision, which has an associated helmet-mounted display for more convenient use. The tank commander received a similar commander's bolt-on armor kit.

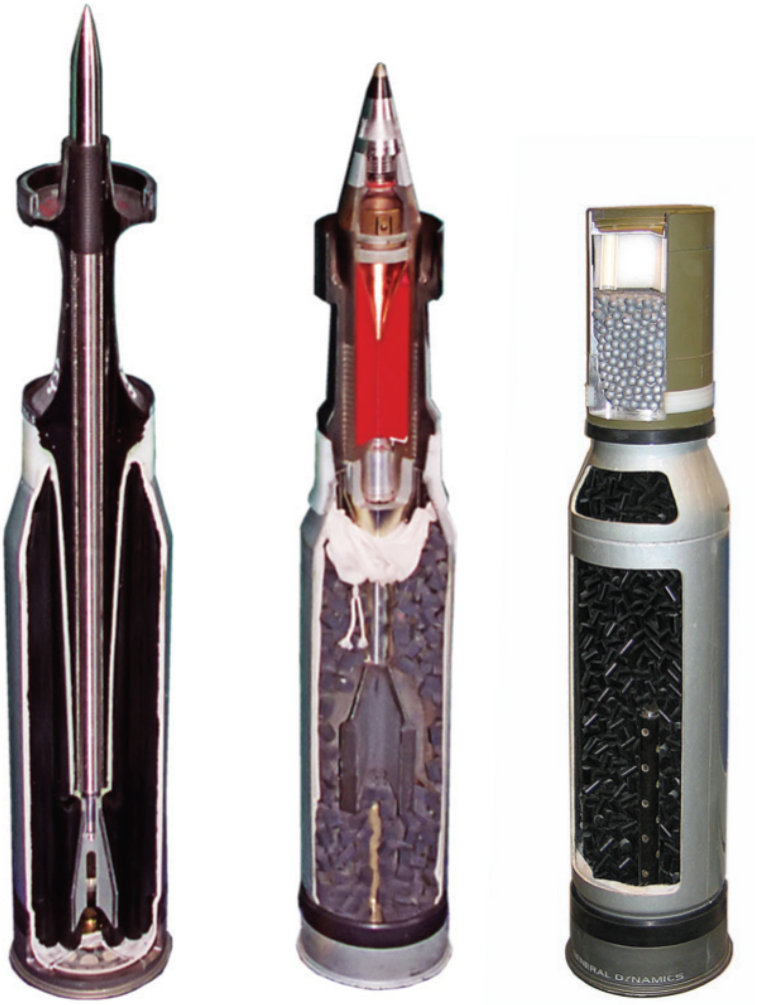
The tank's main gun is often excessive for engaging snipers in an urban environment, so the US Army took a cue from Israeli practices and mounted a .50-cal heavy machine gun over the main gun on a Counter-Sniper/Anti-Materiel Mount (CS/AMM).

Other features added as part of the TUSK program included a tank-infantry phone to allow accompanying infantry to communicate with the tank crew. The driver was provided with an AN/VAS-5 driver's vision enhancer and a thermal night sight permitting night and all-weather vision. M1A1 tanks fitted with TUSK also received a remote thermal sight on the commander's station to allow engagement of urban targets at night with the .50-cal machine gun with the hatch closed.

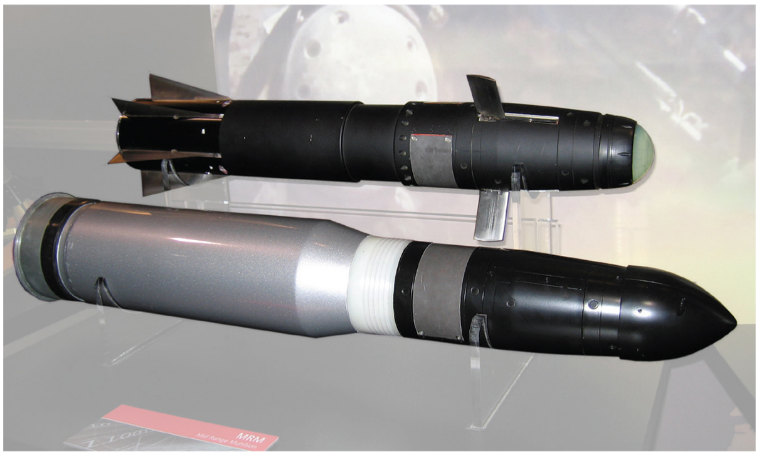
FIREPOWER ENHANCEMENTS

The US Army examined a succession of guided 120mm projectiles in the 1990s, primarily aimed at extending the effective range of the Abrams gun. The XM943 STAFF (Smart Target Activated Fire and Forget) was a 120mm projectile using an active millimeter-wave radar for terminal guidance. Proof-of-principle tests concluded in 1998 without a satisfactory design. In parallel, the Army was also developing the XM1007 TERM-KE (Tank Extended Range Munition-Kinetic Energy) that examined guidance methods for a kinetic energy penetrator as an alternative to the high-explosive shaped-charge warhead on the STAFF. Although development continued for several years beyond the STAFF, the program never reached production.

The next effort was the XM1111 MRM (Mid-Range Munition), which was developed both for the Abrams as well as the Future Combat System. The MRM was designed as a beyond-line-of-sight projectile that could take advantage of the innovations in GPS-based navigation technology on the tank to aim the projectile roughly into the target area, after which an onboard sensor would correct the terminal flight path prior to impact. After studying several competing designs, in January 2008, the Army selected a Raytheon/General Dynamics Ordnance design for engineering development with plans to reach production in 2012. The MRM design was in effect a tube-fired missile, with the projectile using an inertial measurement unit in the initial stage of flight into the target area, followed by optional precision attack modes. In an autonomous mode, the projectile relied on an imaging infrared sensor to locate the target. Alternately, it could use a semi-active laser seeker, with the laser designation coming from the tank or from an independent designator such as an artillery forward observer. In March 2007, a test MRM struck a T-72 tank at 3 miles’ range at Yuma Proving Ground. In the event, the MRM program was canceled in 2010 in connection with the termination of the Future Combat System.



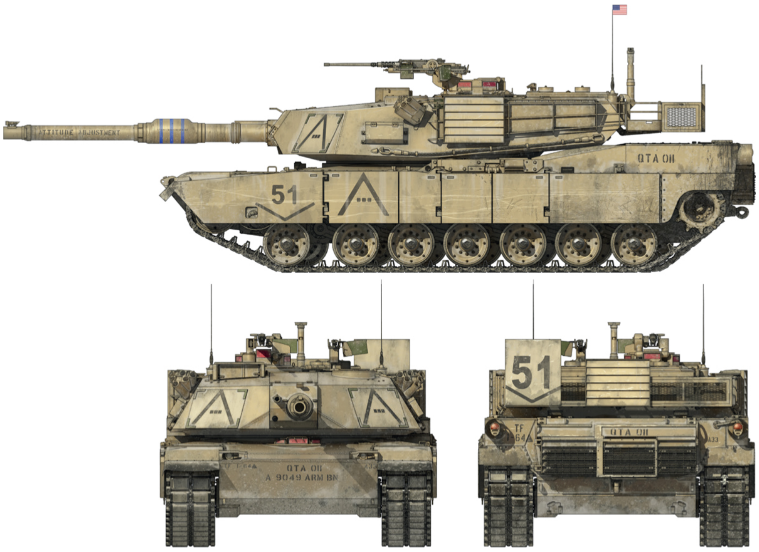
These are three of the new 120mm rounds developed early in the early 2000s. From left to right, they are the M829A3 APFSDS, M830A1 HEAT-MP, and the M1028 120mm canister round. (Author)



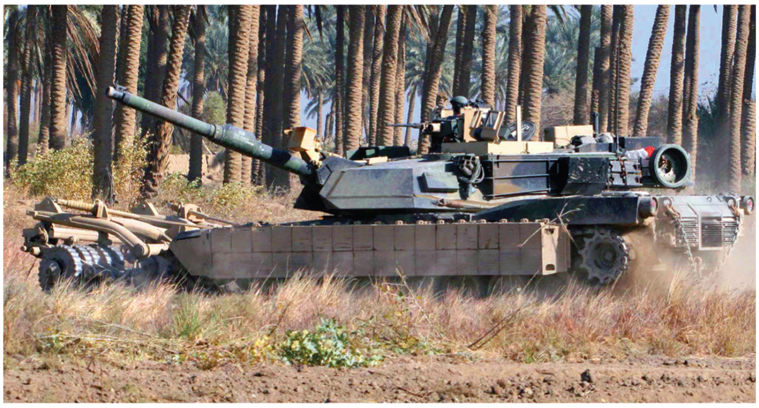
The XM1111 Mid-Range Munition was an attempt to develop a long-range guided projectile for the FCS 120mm gun. This photo shows the complete round below and the projectile itself above, with the protective nose shroud discarded and the guidance fins extended. (Author)

M1A1 SA

Due to the accelerated mechanical exhaustion of Abrams tanks during the Iraq War, in 2004 the US Army instituted a “Reset” program to address the condition of equipment. This placed increased emphasis on reducing the operating costs of the Abrams tank, especially the AGT-1500 engine. As mentioned earlier, the TIGER engine overhaul program was developed by Honeywell and the Anniston Army Depot.



M1A1 AIM, TF 1-64 Armor, 3rd Infantry Division (Mech), Iraq, March 2003. (Artwork by Felipe Rodríguez © Osprey Publishing)



An M1A1 AIM fitted with a mine-clearing roller of Co. B, 1/35th Armor, TF 4-27 "Thunder," 2nd BCT, 1st Armored Division, clears fields in the Jabour area, south of Baghdad, December 15, 2008. This tank is fitted with the basic TUSK kit, including the XM19 ARAT armor. (US Army/ Staff Sgt. Scott Wolfe)

Since it appeared that the M1A1 would remain in the Abrams fleet indefinitely, a RECAP (Recapitalization) program was incorporated into the existing M1A1 AIM modification program. A package of improvements was consolidated into the M1A1 SA (Situational Awareness) program. Many of the improvements had already been applied to the M1A2 as part of the SEP effort.

The M1A1 SA included the Raytheon Block 1 second-generation thermal imaging system and a range of other upgrades, including Blue

Force Tracking (BFT), FBCB2, eye-safe laser rangefinder, the remote thermal sight on the commander's station, the tank-infantry phone, and Far Target Locator (FTL) capability. FTL was a Marine Corps initiative to integrate the data from the laser rangefinder and tank position/navigation system to provide accurate target location out to 8,000 meters for engagement by the tank's main gun or to hand off to the field artillery or supporting aircraft. The M1A1 SA also included the TIGER engine upgrade, front and side armor upgrades, and a host of small safety and maintenance improvements. The first 155 M1A1 SA tank packages were acquired under an August 2006 contract to GDLS. The next step in this program was the M1A1 SA/ED, which added an embedded diagnostics system. A pilot of this version was completed at Anniston Army Depot in January 2008 and the first was delivered in March 2009. The M1A1 SA tanks were delivered to the 1st Infantry Division, 2nd Infantry Division, Army National Guard units, and pre-positioned stocks in Kuwait and Korea. By late 2009, the US Army's heavy brigade combat teams (HBCTs) deployed 2,505 Abrams tanks, consisting of 958 M1A1 SA and 1,547 M1A2 SEP. In 2015, the Army Abrams fleet included 791 M1A1 SA and 1,593 M1A2 SEP tanks.

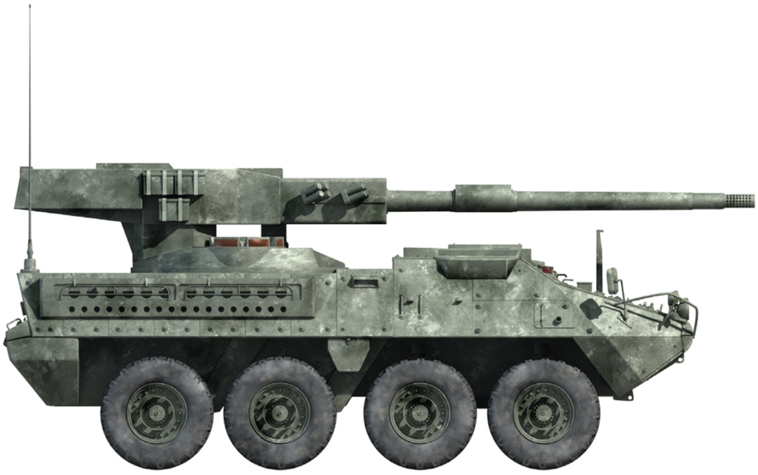
In the 2010s, the M1A2 SEP became the predominant version in active Army HBCT. The M1A1 SA remained in the National Guard ABCT. This is an M1A1 SA of the South Carolina Army National Guard participating in a Combined Arms Demonstration at McEntire Joint National Guard Base, South Carolina, on May 5, 2017, with an AH-64 Apache helicopter overhead. (US Army National Guard/Sgt. Tashera Pravato)

In recent years, the active Army HBCTs have been consolidating around the M1A2 SEP, while the Army National Guard armored brigade combat teams (ABCTs) field both the M1A2 SEP and M1A1 SA. The HBCTs are a combined arms formation that include 60 Abrams, 93 Bradley Infantry/Cavalry Fighting Vehicles, and 17 M109A6 Paladins. In 2009, there were 31 HBCTs consisting of 19 active, seven reserve, three pre-positioned stock, and two equipping force pool units.

STRYKER MOBILE GUN SYSTEM

In October 1999, the new Army Chief of Staff Gen. Eric Shinseki proposed a major transformation of the Army, dubbed the Objective Force, which would be equipped with a new generation of combat vehicles under the Future Combat Systems (FCS). The goal was to move away from the heavy combat vehicles typical of the Cold War to a medium force that would be easier to deploy to global hotspots. The FCS program is detailed from.

An M1128 Stryker MGS with the crews of the 1/17th Infantry at the Yakima Training Center, near Tacoma, Washington state, conducting semi-annual gunnery qualification. (US Army/Sgt. Mark Miranda)



M1128 Stryker Mobile Gun System. (Artwork by Hugh Johnson © Osprey Publishing)

Since FCS wouldn't be available for a decade or more, Shinseki decided to create a stopgap Interim Force in both the active Army and the Army National Guard based around seven brigade-sized units called the interim brigade combat teams (IBCTs). As a result, TARDEC (Tank Automotive Research and Development Command) initiated the Interim Armored Vehicle (IAV) program to equip these new brigades.

The Army conducted a Platform Performance Demonstration at Fort Knox in January 2000. The demonstration mainly focused on wheeled vehicles, such as the Austrian Steyr Pandur, the Textron M1117, the GDLS LAV III, the Arrowpointe Dragoon, the Cadillac Gage LAV 300 Mark II, the GIAT VAB, and the Transportpanzer Fuchs. Several tracked vehicles were also considered, including the ST Kinetics Bionix 25, United Defense Mobile Tactical Vehicle Light (stretched M113), and the M8 Armored Gun System. The Army formally stated that it was not committed to either wheeled or tracked configurations, but there was a strong feeling in the industry that the Army preferred a wheeled configuration. The official position was that most vehicles would be based on whatever chassis was selected as the infantry carrier vehicle, but that the Mobile Gun System (MGS) and howitzer vehicle could be exceptions. The tank surrogate of the IAV family, the MGS, is the focus here since the other variants were primarily infantry or specialized vehicles that are outside the scope of this book. The MGS was an evolutionary follow-on to previous light tank programs such as the M8 Armored Gun System.

United Defense again offered the M8 AGS for the MGS requirement. It was demonstrated to the Army in December 1999 through January 2000. The M8 AGS had little chance after the Army selected the General Motors LAV III in November 2000 for the IAV requirement since it would have meant the adoption of two chassis, the wheeled LAV III and the tracked M8 AGS. The IAV/LAV III subsequently was named the Stryker, after two soldiers who posthumously received the Medal of Honor: Private First Class Stuart S. Stryker, a paratrooper killed during Operation *Varsity* in March 1945, and Spec. 4 Robert F. Stryker, a rifleman killed in November 1967 in Vietnam.

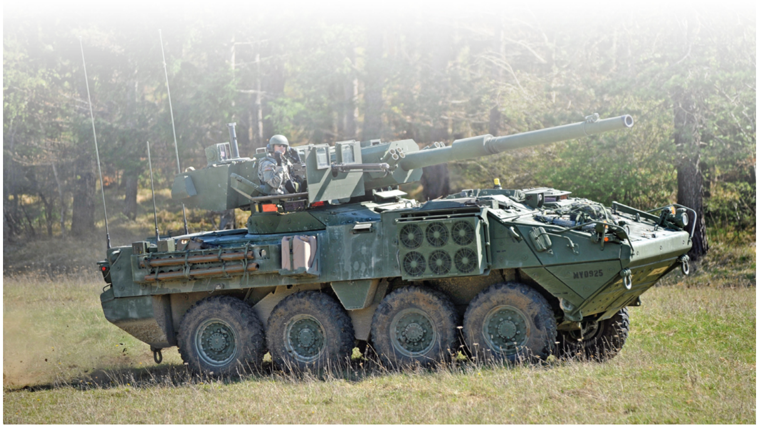
The Stryker chassis was selected as the basis for the Mobile Gun System as the M1128 MGS. The GDLS MGS used a turret derived from the previous AGS program that had been fitted to the GDLS/Textron entry. The M1128 Stryker MGS was armed initially with the M68A1E1 105mm gun, a variation of the same gun used on the M60 and M1 tank series. It underwent continual evolution during production, with the M68A1E4 in FY04, M68A1E7 in FY06, and finally standardization as the M68A2 in FY09.

The 105mm gun was fed by an autoloader and carried 18 ready rounds. The vehicle’s base armor was sufficient to protect against 14.5mm fire. The Stryker MGS combat weight was 20.5 tons in its original version, though this weight increased with subsequent improvements such as Slat armor and the Stryker Reactive Armor Tile II (SRAT II) protection kit.

Initial operational capability was scheduled for December 2001 but quickly slipped. The first pre-production MGS was delivered in July 2002. The 82nd Airborne Division in Iraq wanted some organic armored support, and there was discussion of transferring four of the existing M8 AGS for this mission but this was rejected in January 2005 due to a lack of spare parts. The Stryker MGS was the preferred solution, but it became clear that the M1128 was not mature enough for combat deployment. Delays in fielding the Stryker MGS led to the substitution of the M1134 Anti-Tank Guided Missile Vehicle with the TOW missile in its place when the 3rd Stryker Brigade Team, 2nd Infantry Division, was first deployed to the Middle East in 2002.

The main technical problem with the Stryker MGS was the gun autoloader. After some technical changes. the M1128 MGS was accepted for low-rate initial production (LRIP) in 2004. The MGS was usually deployed on a scale of one vehicle in support of a Stryker platoon or as a three-vehicle platoon in support of a Stryker infantry company.

Initial funding for MPG series production was delayed until the FY03 budget. A limited user test was conducted in April–August 2004 using the initial LRIP vehicles. A report by the Defense Operational Test and Evaluation (DOT&E) office released in early 2005 was scathing: “The MGS demonstrated poor reliability, excessive weapon system dead-space, and other issues associated with gun sights, main gun fire control, and soldier-machine interface… [the testing] identified MGS survivability issues that must be corrected [including] ballistic protection to the crew and the system’s mission equipment package.”

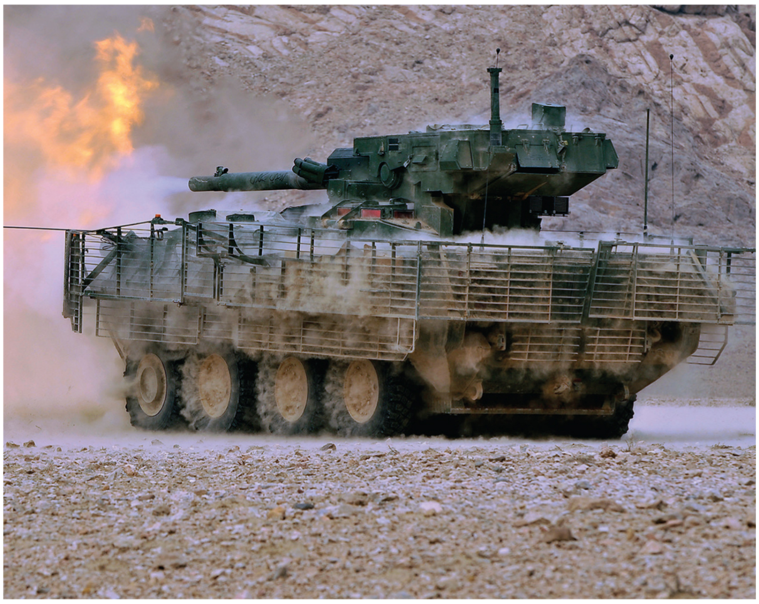


An M1128 Stryker MGC of Apache Company, 1/2nd Cavalry, at the Hohenfels Training Area in Germany, conducting evaluations on April 27, 2012. Overheating problems uncovered in Iraq led to the upgrade of the Stryker with a cooling system on the right hull front as seen here. (US Army/Markus Rauchenberger)

Lingering problems with autoloader performance, ballistic protection of the gun pod, and many other technical issues forced the Secretary of Defense to issue a waiver on July 15, 2008, to allow production of the MGS funded in FY08 to proceed in spite of its problems. The Army planned to fund 305 MGS in FY05–FY09, but due to the unresolved problems, the 48 vehicles scheduled for funding under the FY09 budget were dropped, reducing the objective to 257 vehicles.

Further testing in 2007 found that many of the technical issues were being resolved, but that inherent problems remained. A report noted that the “MGS has excellent speed on roads, although it does not match the mobility and ride quality of tracked vehicles in wet and soft soils.” The vehicle’s automotive reliability was excellent, but the weapon system continued to suffer from malfunctions.

Despite its persistent problems, the MGS was operationally deployed to Iraq in early 2007 with the 4th Stryker BCT, 2nd Infantry Division. Based on these original combat experiences, the FY08 DOT&E report concluded that the “MGS is not sufficiently mature for combat operations. The MGS configuration being deployed into theater was not yet operationally effective.” Iraq uncovered new problems, especially excessive heat buildup inside the crew compartments and frequent failure of the commander’s panoramic viewer due to the heat. As a short-term solution, the crews received micro-climate cooling vests, and a computer cooling system was added to the right front side of the vehicles. These were a partial solution at best.



An M1128 Stryker MGS of the 2/1st Infantry, 5th Stryker BCT, 2nd Infantry Division, during training near Hutal, Afghanistan, on January 21, 2010. The threat of RPG-7 rocket launchers led to the development of a Slat armor kit for the Stryker as seen here. (USAF/Staff Sgt. Dayton Mitchell)

Initial crew reactions to the Stryker in combat were mixed. The crews were very happy with the destructive power of the 105mm gun, and especially its canister round. Aside from being effective against enemy troops, the canister round could be used to strip away foliage from enemy hide-outs. The Stryker MGS sensor system was also highly rated. The Stryker was quiet, maneuverable, and very fast on hard roads and on hard desert terrain.

The widespread use of RPG-7s against Strykers in Iraq led to the development of a Slat armor kit that could be attached externally to the Stryker. This functioned by separating the nose impact fuze from the shaped charge warhead, causing detonation failure or disrupting the propagation of the shaped-charge penetration. The Slat armor was not totally effective against the RPG-7, so as a longer-term solution, a Stryker Reactive Armor Tile (SRAT) was developed starting in 2011.

During combat operations in Iraq, the Stryker was vulnerable to landmines and IEDs. As a technical solution, a Double-V Hull (DVH) was developed for the Stryker family that reduced the effects of mine detonation. This configuration entered production in 2011. In December 2010, an Army board decided not to pursue full-rate production of the MGS. The DVH could not be integrated into the MGS without costly changes due to the depth of the turret system and autoloader.

By 2011–12, the DOT&E noted that most of the MGS problems uncovered in previous testing had been rectified, but some remained insoluble short of a complete redesign of the vehicle. Due to size and weight issues, the MGS could not meet the original criteria for transportability on the C-130 transport aircraft. The external gun pod remained vulnerable. As a result, MGS production was capped at only 142 vehicles, less than half of original plans.

While the entire Stryker family was controversial from the beginning, it was the M1128 Stryker MGS that was the most contentious. In May 2021, the Army announced it would divest itself of the M1128 MGS by September 2022 after only a decade in service after a study showed it was obsolete, its cannon "out-of-date," and its automatic loader plagued with systemic problems. So ended another sorry chapter in the Army's half-century effort to field an expeditionary tank.

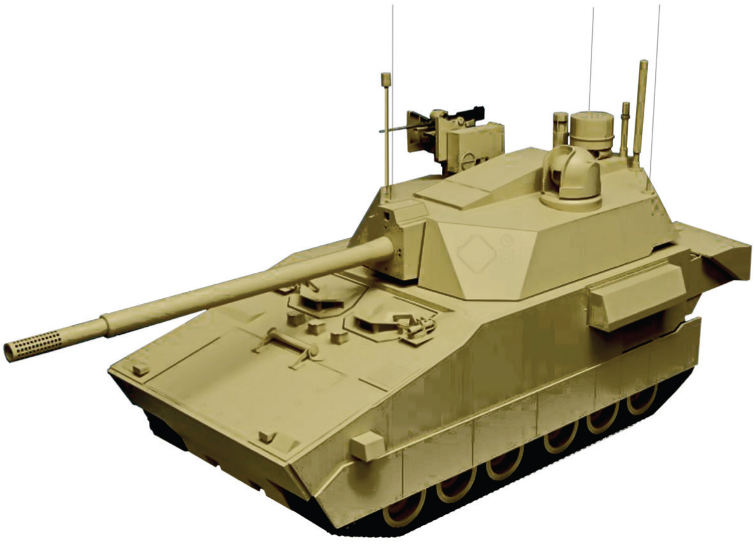
FUTURE COMBAT SYSTEMS

In October 1999, Army Chief of Staff Gen. Eric Shinseki outlined his plans to transform all of the Army's "Legacy Force" into a new configuration called the Objective Force. An essential element of this plan was the Future Combat Systems (FCS), a "system-of-systems" including new combat vehicles, drones, sensors, and an integrated command-and-control system to equip the Objective Force. Shinseki aimed to create a new lightweight Army that could "outsmart and outmaneuver heavier enemy forces on the battlefield." The plan was enormously bold and complex, with the first FCS-equipped Objective

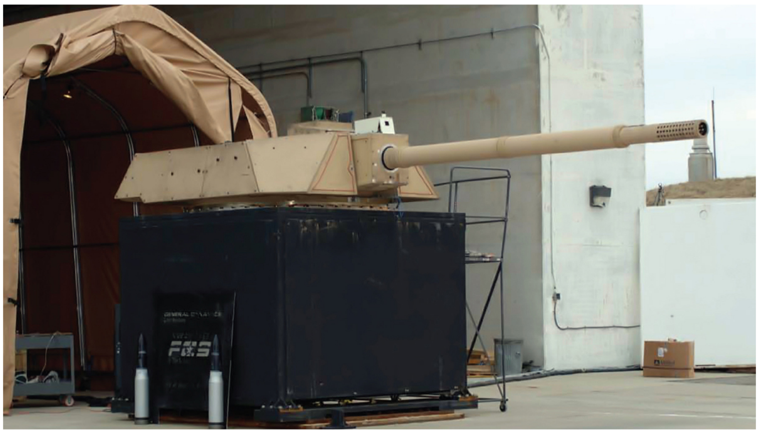
Force unit scheduled to become operational in 2011 with the entire Army transformed by 2032.

Expecting opposition from the existing Army bureaucracy, Shinseki went outside of the Army and gave the task of overseeing the FCS to the Defense Advanced Research Projects Agency (DARPA). The FCS program was so massive and complex that DARPA decided it could not be handled within the Army's existing development structure. Instead, it recommended a plan to have an industry team serve as lead system integrators to manage the program. In May 2000, DARPA awarded four contracts to four industry teams to develop FCS designs. In March 2002, Boeing and Science Applications International Corporation (SAIC) were selected as the lead system integrators. In August 2004, the Boeing/SAIC team awarded contracts to 21 companies to design and build its various FCS combat vehicles and systems.

In August 2003, Gen. Peter Schoomaker replaced Shinseki as the Army Chief of Staff. He immediately reoriented the FCS program, relabeling the Objective Force as the Future Force, and placing greater emphasis on the networks linking Army forces rather than on the actual FCS combat vehicles. FCS was expected to be one of the most expensive Army programs in history, costing $157 billion for research, development, and procurement from FY2005 through 2022.



The tank member of the Future Combat Systems family of vehicles was the XM1202 Mounted Combat System. No prototype was completed prior to the cancelation of the program.



The XM1202 MCS tank proceeded only as far as a turret test bed for the 120mm XM360 gun, seen here during trials at Aberdeen Proving Ground in 2009.

The Manned Ground Vehicles (MGV) element of FCS included eight principal vehicles that shared a common chassis, powertrain, and other features. The XM1202 Mounted Combat System (MCS) was the FCS tank with development undertaken by GDLS. Each brigade was expected to have 60 MCSs. The MCS had a crew of only two, the driver and commander, both located in the hull. The turret was completely automated and had a 120mm XM360 gun and associated autoloader. The secondary armament included a remote-control .50-cal machine gun on the roof and a 40mm grenade launcher. The MGV family was intended to have armor sufficient to defend against 30mm gunfire in the frontal 60-degree quadrant and protection against 14.5mm gunfire from all around. To reduce the vulnerability of the MCS to hostile fire, the Army was developing the Mid-Range Munition (MRM), a guided 120mm round that could be fired at targets beyond the line of sight, relying on data from the FCS network such as accompanying drones. Overall vehicle weight of the MGV gradually climbed from the goal of 20 tons, then to 23.8 tons, and eventually to 30 tons.

Propulsion for the MGV was provided from a hybrid-electric Traction Drive Subsystem (TDS) consisting of a 550hp MTU diesel engine driving a 418kW Williams International generator that fed electrical power to a lithium-ion storage battery. The stored electricity was used by the electric motor drives for the vehicle propulsion as well as all the vehicle's electrical subsystems. The first TDS was delivered in

2007 for tests. The MGV program went into engineering development in the spring of 2003 with plans to go into production in 2012.

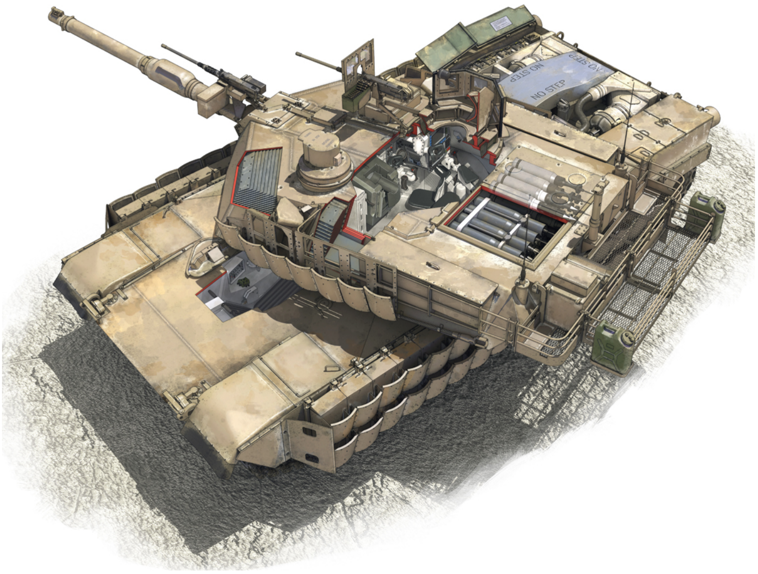
The FCS program began to run into technological and political problems from the outset. The program assumed that the defense industry could develop both evolutionary and revolutionary technologies on a parallel schedule. The concurrent development of the system-of-systems created considerable disharmony in the engineering effort since unproven but essentially new subsystems were frequently behind schedule if not entirely beyond state-of-the-art. The greatest challenge was the immaturity of intelligence fusion technology at the heart of FCS that required a network of sensors to provide and analyze a mass of data and distribute it in a timely fashion to dispersed vehicles under combat conditions. On the automotive side, major subsystems, such as the hybrid propulsion system and the crew interface with sensors and data handling systems, were unproven. The aim to make the MGVs light enough to be transportable in the C-130 transport aircraft required extreme compromises in the armored protection of the close-combat vehicles, such as the XM1022 MGS. The Army did not have a clear grasp of which technologies were feasible and which were unrealistic within the allotted timeframe.

Within a few years of the start of the FCS program, considerable criticism was developing within the Army and Congress. The long-term cost estimates for the FCS were disturbing, and there was skepticism that the core technologies could be developed on schedule, if at all. Even if the MGV could be developed on time and on budget, there was growing doubt that the XM1202 MCS “tinker-toy tank” would be durable enough in real-world combat conditions. Due to its light armor, combat survivability was dependent upon a Hit Avoidance System, including an Active Protection System that had not completed development.

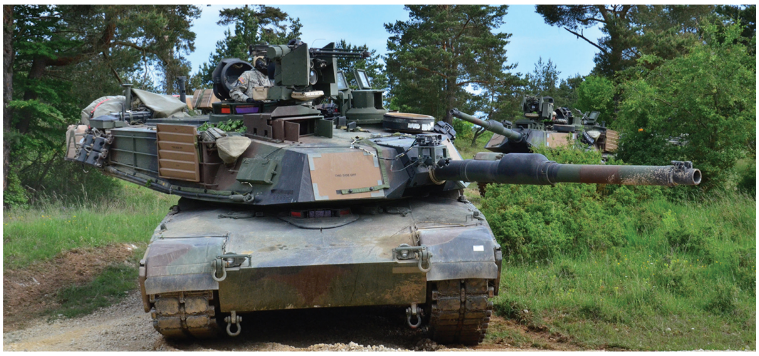
After studies by the Congressional Budget Office, Government Accounting Office, and others, on April 6, 2009, Secretary of Defense Robert Gates announced that he intended to significantly restructure the FCS program. Gates recommended canceling the MGV portion of the program while spinning off some of the other technologies as they proved viable. At the time of its cancelation, the FCS program had already cost about $18 billion. A prototype for only one MCV had been completed, the XM1203 Non-Line-of-Sight Cannon (NLOS-C), and this was powered by a conventional Detroit diesel 5L890 engine until the new hybrid propulsion system was ready. The XM1202 MCS proceeded no further than a turret test bed at the time the program was canceled.

THE POST-OIF M1A2 ABRAMS UPGRADES

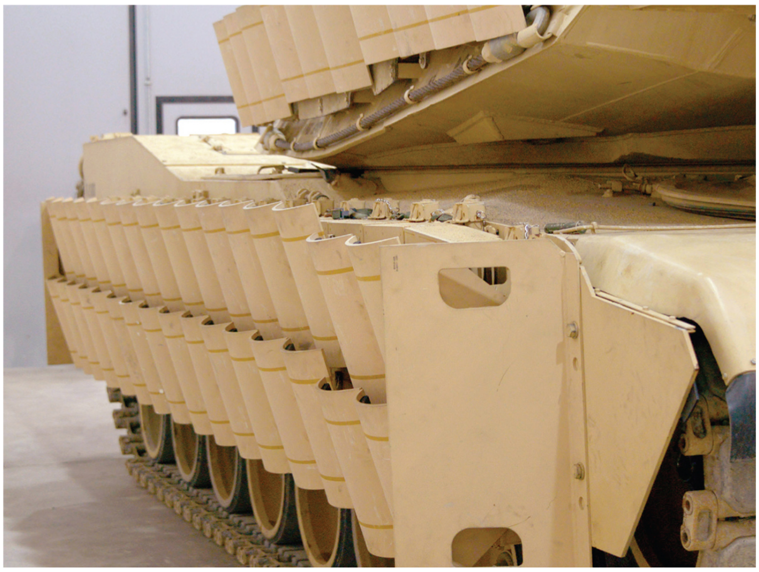
The withdrawal of the US Army from Iraq began in December 2007 and was completed by December 2011. Modernization of the Abrams fleet had stagnated during this period except for those aspects of the program connected with operations there such as TUSK. Aside from war costs, the heavy drain of US Army funding into the misbegotten FCS program was the most critical impediment to Abrams' modernization since it was presumed that the Army would be converting to a new generation of combat vehicles in the decade ahead. The April 2009 cancelation of the FCS program meant that the M1A2 Abrams would remain the core of the Army tank force for the foreseeable future.



M1A2 with TUSK II. (Artwork by Felipe Rodríguez © Osprey Publishing)



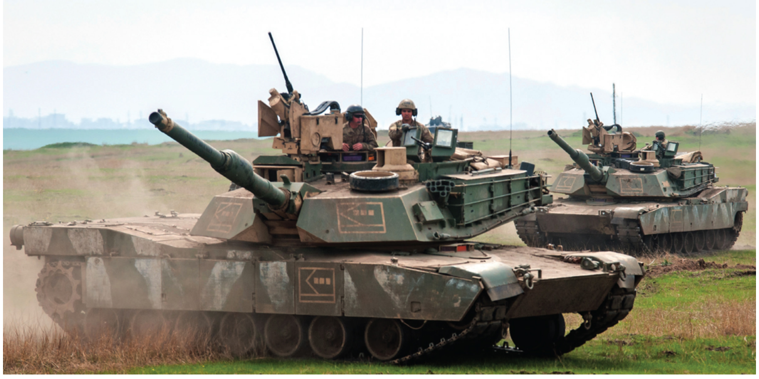
An M1A2 SEPv2 of 2/5th Cavalry, 1st Cavalry Division, during Exercise Combined Resolve II in Germany on May 26, 2014. This tank has the CARC Tan Combat Identification Panels and is fitted with the I-MILES laser-simulation training equipment. (US Army/Spc. John Cress Jr.)



The TUSK II kit includes a second layer of curved XM32 ARAT over the XM19 ARAT boxes. This is an M1A2 SEPv2 assigned to the 1/66th Armor, 3rd ABCT, 4th Infantry Division, at Grafenwöhr Training Area, Germany, on February 28, 2017. (US Army/Gerhard Seuffert)

The next stage in M1A2 evolution was the M1A2 SEPv2. The most visible change on this version was the addition of an M153A1E1 CROWS LP (Common Remotely Operated Weapon Station Low Profile) in front of the commander's station. This system allows the .50-cal machine gun to be remotely aimed and fired by the commander from within the tank. There were problems with this system, since vibrations from the weapon firing could shake the gunner's thermal imaging sight below.

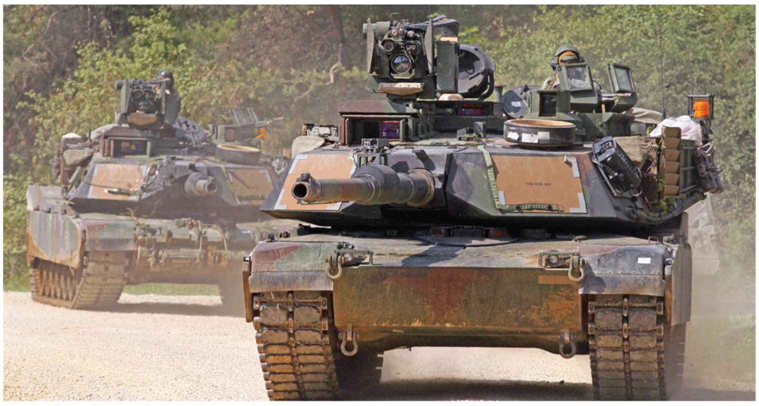
Aside from the CROWS-LP, most of the changes in in the M1A2 SEPv2 were internal. The fire control system was upgraded to permit the use of the new M829A3 APFSDS projectile and M1028 canister projectile. Digital improvements continued, including improved microprocessors and memory upgrades, new color flat-panel displays, and the new Common Operating Environment (COE) computer operating system. The Gunner's Primary Sight and Commander's Independent Thermal Imaging Sight were both upgraded from the Block 0 to the Block 1 HTI-SGF second-generation thermal imaging technology. Both frontal and side armor were improved. The M1A2 SEPv2 incorporated the TIGER engine, a battery-based auxiliary power unit, and an upgraded transmission.



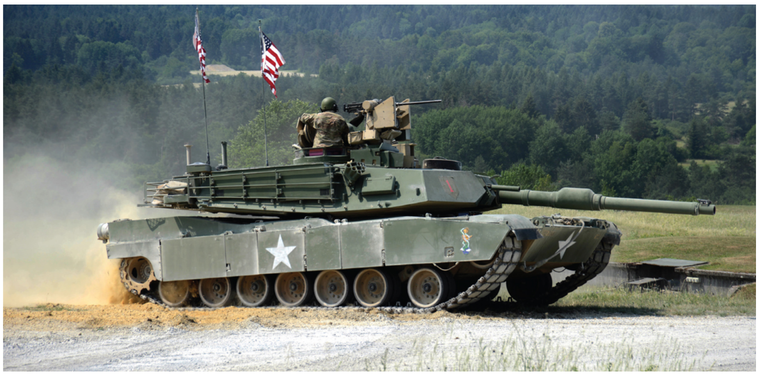
A pair of M1A2 SEPv2 Abrams tanks of Co. C, 1st/18th Infantry, 2nd ABCT, 1st Infantry Division, from Fort Riley, Kansas, take part in Justice Eagle, a bilateral live-fire exercise with the Romanian army on April 17, 2018, at Smardan Training Area, Romania. (US Army/ Staff Sgt. Matthew Keeler)

GDLS was awarded a contract in February 2008 to upgrade 435 M1A1 tanks to the M1A2 SEPv2 configuration. The 4th Brigade, 1st Cavalry Division, was the first unit equipped with the M1A2 SEPv2. Deliveries in 2009–10 subsequently included the 1st Brigade, 1st Armored Division, and the 4th Infantry Division. In 2011–12, deliveries were extended to the 2nd Infantry Division and 3rd Infantry Division. The M1A2 SEPv2 was also deployed with the Army National Guard, including the 115th ABCT (Mississippi ARNG), 116th ABCT

(Idaho ARNG), and the 2/137th Combined Arms Battalion (Kansas ARNG). Production of the M1A2 SEPv2 for the US Army concluded in January 2017.

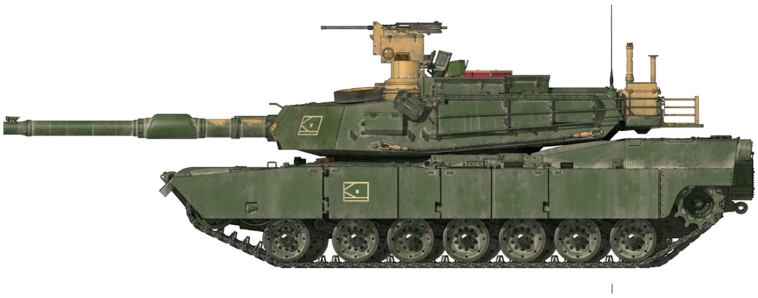


M1A2 SEPv2 Abrams tanks of Co. C, 2/5th Cavalry, 1st BCT, 1st Cavalry Division, take part in the Combined Resolve II maneuvers at Hohenfels Training Area in Germany in April 2015. This tank is fitted with the various components of the I-MILES CVTESS, including a laser transmitter on the gun mantlet and an orange beacon on the left rear corner of the turret. The device on the turret side in front of the loader is a Main Gun Signature Simulator which contains 60 small pyrotechnic charges that are detonated to simulate the main gun firing during maneuvers. (US Army/Capt. John Farmer)

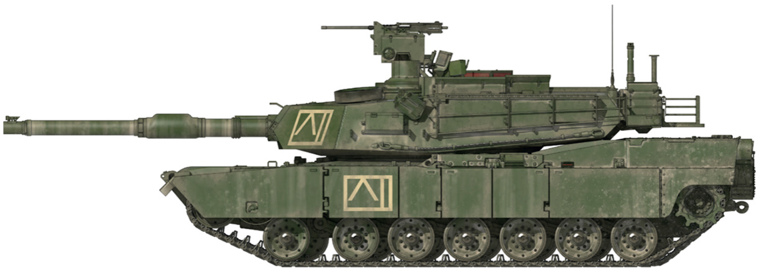


An M1A2 SEPv2 of the 2/70th Armor, 2nd ABCT, 1st Infantry Division, participating at the Strong Europe Tank Challenge at the Grafenwöhr Training Area in Germany in June 2108. For the competition, the tank has been painted in markings commemorating World War II, including the "Joe Peckerwood" turtle insignia carried by the 70th Tank Battalion at Utah Beach in Normandy on D-Day 1944. (US Army, Matthias Fruth)

Continuing M1A2 SEP improvements were outlined in a set of Engineering Change Proposals (ECP) that were approved in June 2011. ECP 1A (Power) included an updated Handheld Manpack Small (HMS) communication system, a new 1,000amp generator, an updated power management distribution system, the integration of the CREW/Duke 3 IED jammer, Next Evolutionary Armor (NEA), an Ammunition Data Link (ADL) to optimize smart round effects, and the upgrade of line replaceable units (LRUs) to line replaceable modules (LRMs). GDLS was awarded a development contract for this effort in September 2012. The ECP 1A configuration eventually emerged as the M1A2 SEPv3, with the first six tanks funded in FY15 and deliveries of the FY15 tanks at the Joint Systems Manufacturing Center (JSMC) in October 2017. JSMC is the new name for the Lima Army Tank Plant.



M1A2 SEPv2, 1/18th Infantry, 3rd ABCT, Romania, 2017. (Artwork by Felipe Rodríguez © Osprey Publishing)



M1A2 SEPv2, 1/63rd Armor, 2nd ABCT, Germany, 2018. (Artwork by Felipe Rodríguez © Osprey Publishing)

The next stage of the process is the ECP 2, aimed at developing what could become the M1A2 SEPv4 sometime after 2024. This will continue the process of evolutionary change on a variety of systems, including a new generation of armor, upgraded sensors, and new ammunition.

The primary focus of the Abrams Lethality ECP improvements is the development of third-generation thermal-imaging systems for the Gunner's Primary Sight and the Commander's Independent Thermal Viewer. The program is also adapting the Ammunition Data Link (ADL) for the forthcoming XM1147 Advanced Multi-Purpose (AMP) round. The Army is interested in the AMP round as a means to replace several existing rounds, including the M830A1 HEAT-MP-T, M908 HE-OR-T, and M1028 canister with a single, multi-purpose round. The round will feature a programmable fuze that can be set for airburst, detonation-on-impact, and delay-after-impact. The AMP works in conjunction with the new ADL so that the round can be immediately reprogrammed even when in the gun chamber. The Army is also developing a new APFSDS projectile, the M829E4. Additional improvements being considered include an improved environmental control system, a laser warning receiver, and vehicle smoke generation.

SWANSONG FOR MARINE TANKS

The US Marine Corps remained committed to the M1A1 since it faced more stringent weight restrictions than the Army due to its maritime amphibious deployment requirements. As a result, the Marine Corps did not follow the US Army's M1A1 program improvements. Instead, the Marine Corps adopted features from the Army that it considered essential, as well as improvements based on its own requirement.

The Marines refreshed their Abrams tank fleet by means of transfers from the Army. So, in 2004–07, the Army transferred 144 M1A1 tanks to the Marine Corps and a further 80 in 2007–08, which had undergone the Army's recapitalization program. The Marine Corps then added its own modifications to these tanks and sent a corresponding number of older tanks back to the Army for rehabilitation by the joint Anniston Army Depot/Joint Systems Manufacturing Center process.

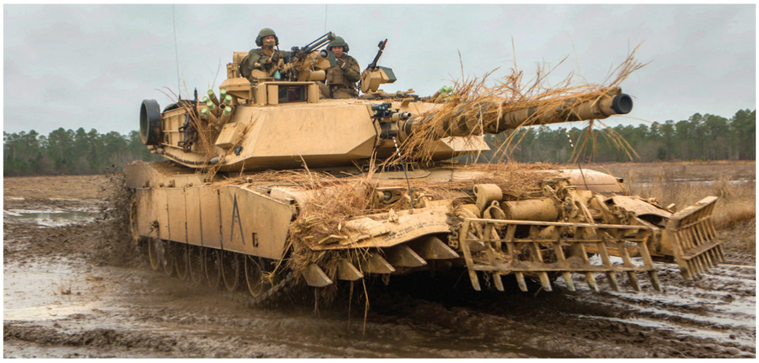
An M1A2 SEPv3 of Bravo Company, 1/9th Cavalry, 2nd ABCT, 1st Cavalry Division, during gunnery qualification at Fort Hood, Texas, on October 19, 2021. (US Army)

The focus of the Marine modifications immediately after 2000 was the Firepower Enhancement Program (FEP). This was designed to improve the ability of the crew to engage targets faster, at greater range, and in all weather. The FEP package included HTI-SGF second-generation thermal sights, a north-finding, far-target location system, the ELRF eye-safe laser rangefinder, and a thermal sight for the .50-cal machine gun. The development program concluded in November 2004 and the installation program in late 2005, eventually affecting 386 tanks by the time it was completed in early 2010. In 2009, the Marines began a program to fit their M1A1 tanks with External APUs. The next package of improvements was the Survivability and Lethality

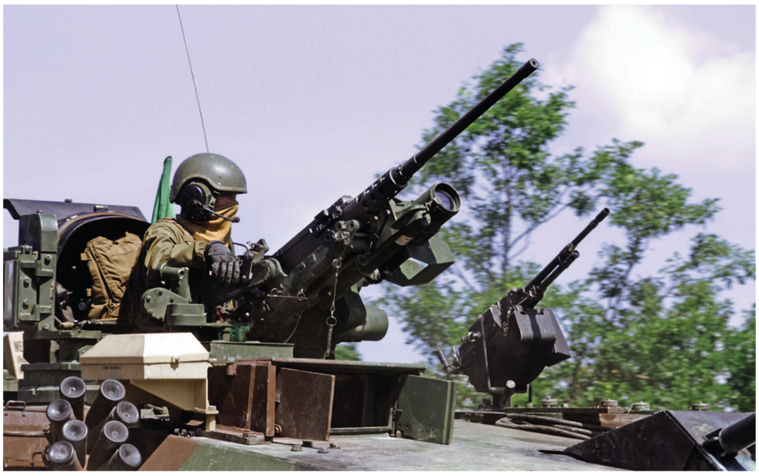
Enhancement Program, based in large measure on the lessons of the Iraq conflict. Under this program, 160 tanks were upgraded with belly armor kits and improved driver seats. This was followed by an Abrams Suspension Upgrade (ASU), Situational Awareness Enhancements (SAE), and a Slew-to-Cue feature. Slew-to-Cue allows the tank commander to automatically traverse the main gun to the same azimuth and elevation as the Stabilized Commander's Weapons Station (SCWS) sight with a single push of a button. In 2015, the Marines began to acquire the Abrams Integrated Target and Display System (AIDATS) that significantly improved the tank commander's displays. In 2018, the Marines began updating the M1A1 fleet with the Improved Side Armor (ISA) kit.

It's worth noting that the Marine Corps did not apply modified designations for these various improvement packages, though the US Army sometimes refers to their tanks as M1A1 MC (Marine Corps) to recognize that they incorporate features that are not identical to those on US Army M1A1 tanks.

In March 2020, the new Marine Commandant Gen. David H. Berger announced a major shift in Marine Corps structure to conform to his new Force Design 2030. As part of the plan aimed at making the Marines "light and expeditionary" for a conflict in the western Pacific, Berger decided to dump the Marine tank force and depend on Army tank units should the need arise. At the time, the Marines had 452 M1A1 tanks. By the end of 2020, 323 had been transferred to the Army, while those in overseas storage and aboard maritime prepositioning ships were transferred in 2023. This ended nearly a century of Marine Corps tanks. Berger's decision was controversial, and it is by no means certain that this is the final word on the matter.



An M1A1 Abrams Tank of the 2nd Tank Battalion, 2nd Marine Division, with track-width mine plow and the centerline diverter kit on maneuver training at Fort Stewart, Georgia, on February 10, 2018. Several of the recent upgrades are evident on this tank, including the thermal sight on the commander's .50-cal machine gun and the BFT/GPS antenna to the side of the Gunner's Primary Sight. (US Marine Corps/Cpl. Alexander Sturdivant)

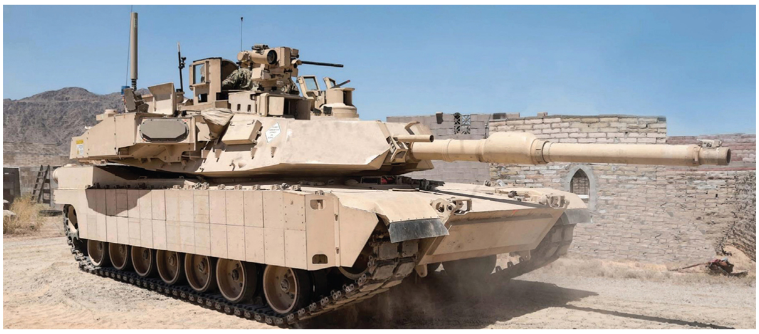


This M1A1 shows some of the features unique to the Marine Corps, such as the eight-round M257 grenade launcher and the thermal imaging sight configuration on the .50-cal heavy machine gun. The tan box adjacent to the Gunner's Primary Sight housing is the antenna for the Blue Force Tracker/GPS system. This is a tank of 4th Tank Battalion, 4th Marine Division, at Camp Grayling Joint Maneuver Training Center in Michigan on July 31, 2017. (Michigan National Guard/ Spc. Savannah Lang)

ABRAMS ACTIVE PROTECTION SYSTEMS

The US Army has been investigating both hard-kill and soft-kill active protection systems (APS) for decades. These systems are typically designed to shield the tank against RPGs and ATGMs. Soft-kill systems are designed to interfere with the guidance systems of ATGMs. In the 1980s, the US Army acquired over 3,500 VLQ-6 and VLQ-8 Missile Countermeasure Devices. These emitted an infrared signal to interfere with the optical command link between typical Soviet ATGMs and their launchers. These were fitted to some M1A1 tanks during Operation *Desert Storm*. Research was also undertaken on a variety of hard-kill APS systems, including the Raytheon Small Low Cost Interceptor Device (SLID) guided munition, though none reached the production stage. Hard-kill APS systems are designed to attack the enemy rocket or missile. These usually involve some sort of small projectile or munition to destroy the warhead of the incoming rocket or missile to prevent it from detonating.

The US Army funded Raytheon to develop its Quick Kill APS system for the FCS program. Even after the FCS program was canceled in 2009, the Quick Kill Program was continued for potential successor efforts, such as the short-lived GCS (Ground Combat System). Foreign systems were also examined. The Israeli Trophy system, developed by Rafael, was rejected by the US Army in 2006 in favor of continued development of Quick Kill. The Trophy began to be deployed on Merkava tanks of the Israeli Defense Force in 2009, and it was first used in March 2011 when a Trophy-equipped Merkava 4 intercepted an anti-tank missile launched from Gaza. The US Congress was not happy with the slow pace of US Army APS development and appropriated additional funding in FY17 for the US Army to acquire Trophy as a non-developmental item. As a result, the FY18 budget continued to fund development of the new Modular APS (MAPS) program while at the same time providing immediate procurement funding for Trophy integration on the M1A2 SEPv2.

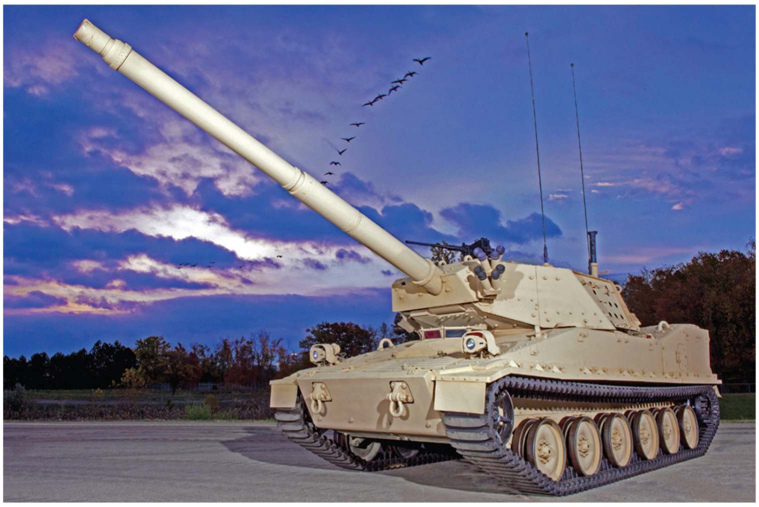


One of the M1A2 SEPv2 test vehicles fitted with the Trophy HV active protection system. The octagonal antenna of the EL/M 2133 radar can be seen on the side, and the MEFP munition dispenser above and slightly behind the antenna. (US Army)

The Trophy uses a set of Elta EL/M 2133 radars mounted on the turret to detect an approaching munition. The onboard computer then tracks the munition, determines the intercept parameters, alerts the crew, and then automatically discharges an MEFP munition (multiple explosive formed penetrator) that intercepts the threat and destroys its warhead a safe distance from the tank, usually about 10–30 meters. The MEFP munition disperses about three dozen small pellets to shred the incoming warhead. Rafael teamed with Leonardo DRS in St. Louis to offer the upgraded Trophy HV to the US Army. In September 2017, the Army awarded Leonardo DRS a contract for the eventual production of 261 Trophy HV kits to retrofit M1A2 SEPv2 tanks.

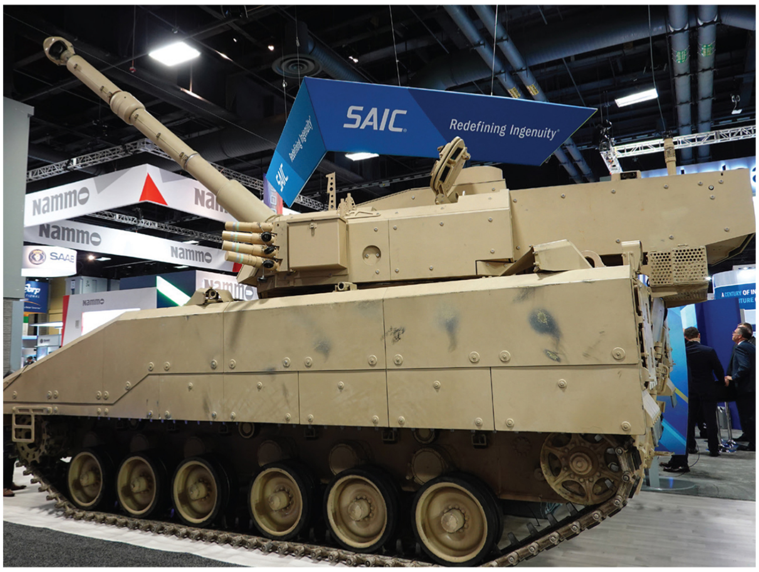
M10 BOOKER MOBILE PROTECTED FIREPOWER

Following the cancelation of the XM1202 Mounted Combat System, the Army continued to evaluate its needs for a tracked combat vehicle to provide fire support for its infantry combat brigade teams. The requirement for a Mobile Protected Firepower (MPF) vehicle was first laid out in the Army's combat vehicle modernization strategy released in October 2015. In contrast to the high-tech FCS, the MPF was described as an off-the-shelf vehicle with a combat weight no more than 32 tons. This was basically a revival of the M8 Armored Gun System, but with heavier armor and correspondingly without the air-drop capability. The requirement was for frontal protection from 30mm automatic cannons, a caliber common on infantry fighting vehicles. A request for proposal to industry was released in November 2017.

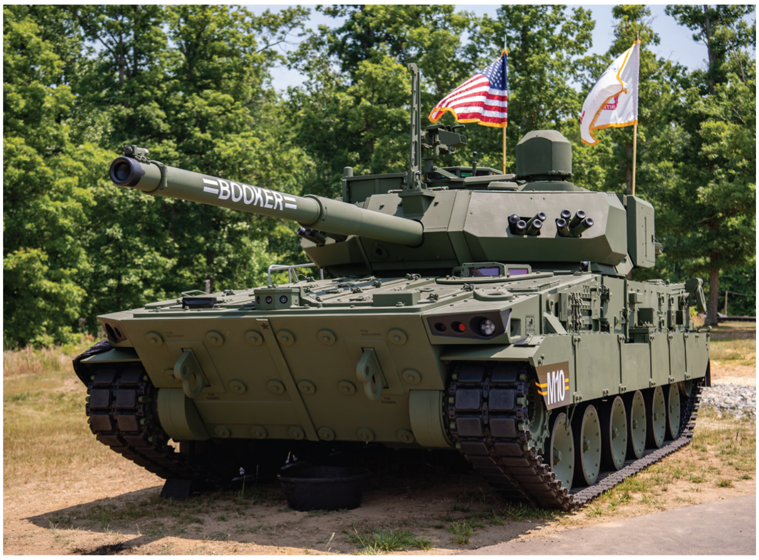


One of the contenders for the XM1302 MPF program was this BAE Systems entry, based on the earlier M8 Armored Gun System.

There were three contenders for MPF. A team headed by SAIC offered the ST Kinetics Next Generation Armored Fighting Vehicle hull fitted with the CMI Cockerill 305 turret. BAE Systems, which had taken over United Defense, offered a vehicle derived from the earlier M8 Armored Gun System. GDLS offered a variant of the Griffin II that was itself based on a chassis originally developed for the Austrian-Spanish ASCOD and later the British Ajax.



Another contender for the MPF requirement was this ST Kinetics Next Generation Armored Fighting Vehicle and CMI Cockerill 305 turret with SAIC serving as the system integrator. (Author)



The M10 Booker MPF vehicle during its unveiling on June 10, 2022.

On December 17, 2018, the Army narrowed competition to BAE and GDLS, with contracts to build prototypes of the XM1302 MPF. These were delayed by the COVID pandemic, with GDLS delivering its prototypes by December 2020 and BAE by February 2021. The trials were conducted at Fort Bragg starting in January 2021. The BAE XM1302 MPF was disqualified in March 2022 due to "noncompliance issues." This left the GDLS contender as the Army's sole choice, and the formal selection took place on June 28, 2022.

The XM1302 MPF was officially designated M10 Booker on June 11, 2023 in joint honor of Pvt. Robert D. Booker, an infantryman of the 34th Division who was posthumously awarded the Medal of Honor for heroic actions in Tunisia in 1943; and Staff Sgt. Stevon A. Booker, a tanker with the 3rd Infantry Division who received the Distinguished Service Cross posthumously for life-saving valor in the 2003 Iraq invasion.

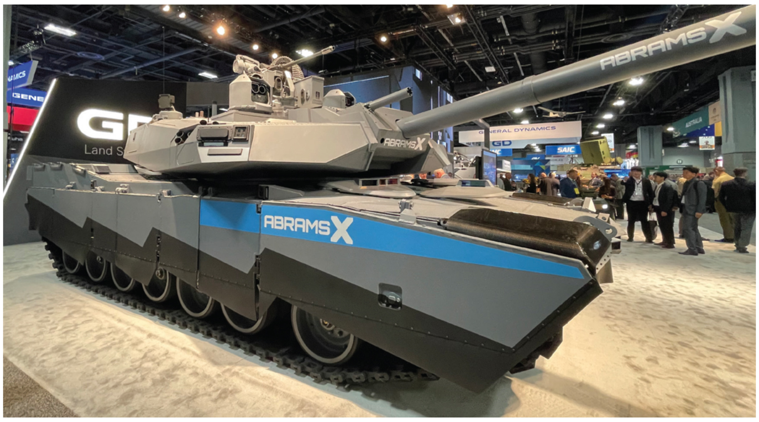
Army officials were adamant that the M10 was not a tank, sometimes referring to it as an infantry assault gun. The Army describes its mission as to neutralize enemy defensive positions and bunkers, and to defeat heavy machine guns and armored vehicle threats during offensive operations. During defensive operations, the M10 Booker is expected to provide fire support against attacking enemy forces. The MPF battalions are expected to be deployed at divisional level with a strength of 42 vehicles. In turn, each infantry brigade combat team can be supported by an MPF company of 14 vehicles.

The M10 is armed with the 105mm M35 gun that armed the previous M8 Buford AGS. The fire controls are essentially similar to those of the M1A2 SEPv3. It has a loaded weight of 42 tons, so it is certainly not a light tank. Indeed, its weight is comparable to many standard Russian tank types, such as the T-72 and T-90. The M10 is powered by an 800hp MTU diesel with an Allison 3040 MX cross-drive transmission.

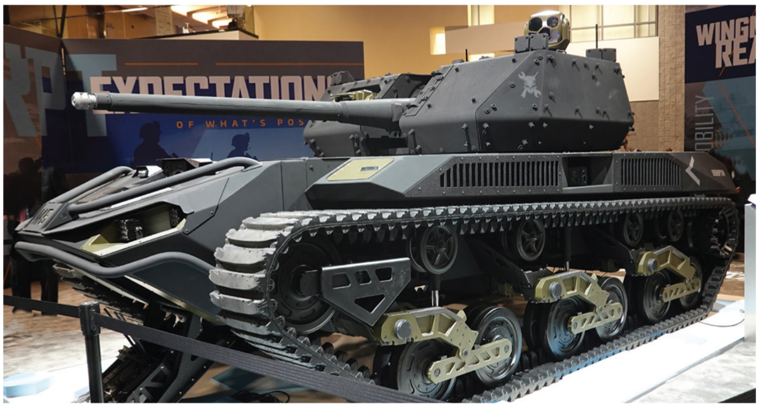
Initial funding for the M10 Booker was provided in the FY22 budget at a unit cost of $12.4 million each, with the first production vehicle delivered in May 2024. Production is expected to continue through 2035, assuming that all of the planned 504 vehicles are funded. General Dynamics has already displayed a model of a Medium Weight Recovery Vehicle (MWRV) based on the chassis, presumably to support the MPF units.

INTO THE FUTURE

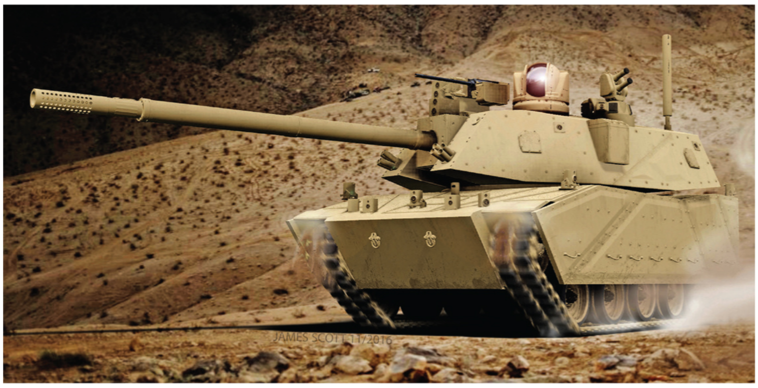
In 2009, the US Army initiated the Ground Combat Vehicle (GCV) program, a less expansive effort than the failed Future Combat Systems. The initial focus of the GCV program was the development of an infantry fighting vehicle to replace the M2 Bradley, the Optionally Manned Fighting Vehicle (OMFV). The program was canceled in 2017. GCV was followed in 2019 by the Next Generation Combat Vehicle (NGCV) program. This is an enlarged effort to develop several armored combat vehicles, including the Decisive Lethality Platform (DLP) to replace the M1 Abrams main battle tank; the XM30 Mechanized Infantry Combat Vehicle (MICV) to replace the M2 Bradley IFV; the Armored Multi-Purpose Vehicle (AMPV) to replace the M113; the M10 Booker Mobile Protected Firepower (MPF); and the Robotic Combat Vehicle (RCV).



The shape of things to come? In October 2022, GDLS displayed the Abrams X concept tank at the Association of the US Army convention in Washington, DC. Like the M1 Tank Test Bed from a half-century before, the three crew are in a front capsule in the hull while the turret is entirely automated. (Author)



Is the future robotic? This is the Textron M5 Ripsaw, a 10-ton robotic vehicle armed with a Mk44 Bushmaster II 30mm chain gun, on display at the 2019 AUSA convention in Washington, DC, as a candidate for the Army's Robotic Combat Vehicle (Medium) program. (Author)



A notional Robotic Combat Vehicle (Heavy) Decisive Lethality Wingman designed to accompany future manned tanks as part of the Army's Next Generation Combat Vehicle as shown in this 2019 Army computer illustration.

As has been the case in the past, the Army is pursuing a mixed evolution/revolution path for its main battle tank. Options have included further evolution of the M1A2, such as M1A2 SEPv4 via conversion of existing tanks, construction of new M1A2 tanks, or a new future tank. In 2022, General Dynamics unveiled its concept for a Decisive Lethality Platform, called Abrams X. This incorporates a three-crew compartment in the hull front along with an automated turret.

The GCV program has also begun to examine the future of RCVs. These could be used on their own or teamed with tanks and other armored vehicles as "tank wingmen." These platforms are viewed as multi-functional. Some may be armed with guns or missiles, but others may be used with electronic systems to provide counter-drone defense. Initially, three different sizes were envisioned: RCV-L (Light), RCV-M (Medium), and RCV-H (Heavy).

In March 2020, the Army awarded a team of Textron Systems, Howe & Howe Technologies, and FLIR Systems to build four RCV-M prototypes based on their M5 Ripsaw design. In May 2022, the Army decided to postpone the RCV-M in favor of concentrating on the smaller RCV-L. In September 2023, the Army picked four teams to build RCV-L prototypes, consisting of McQ Inc., Textron Systems, General Dynamics Land Systems, and Oshkosh Defense. The Army plans to spend nearly $1 billion through the 2020s to examine the Robotic Combat Vehicle concept.

CONCLUSION

Several themes emerge in this study. As in World War II, the period from 1950 to 1960 was extremely turbulent due to the Korean tank crisis and escalating Cold War tensions. Tank evolution was continuous and hasty, with the US Army starting the decade with the M26 medium tank and rapidly progressing through the Patton series of the M46, M47, M48, and M60. The Patton family saw incremental technical advances, for example the switch from fuel-injected gasoline engines to diesel, and the modest switch from 90mm to 105mm main guns. The frantic pace of US tank development largely subsided by the early 1960s. US tank evolution reached an evolutionary plateau with the M60 tank. Although the M60 was widely viewed as a warmed-over M48 Patton and nothing more than an interim tank, it remained the predominant type for two decades until the early 1980s.

With the arrival of the M1 Abrams, another evolutionary phase began and continued at a very slow pace. The M1 Abrams has remained the principal Army battle tank for 45 years, by far the longest time of any tank in US Army history. This was due in no small measure to the end of the Cold War and the resulting end of the arms race between NATO and the Warsaw Pact. With no future Soviet tank to worry about, Abrams' improvements were slow and incremental. The Abrams is likely to serve another decade or more.

Attempts to develop more radical tanks, such as the T95, MBT-70, AMS Block III, or FCS XM1202 Mounted Combat System, all failed. In most cases, they were beyond the state-of-the-art, too expensive, and not sufficiently beyond the combat effectiveness of the existing tanks to justify their manufacture. The end of the Cold War in 1990–91 also undermined the rationale for more sophisticated battle tanks. This trend has been evident across the globe, with most major armies today relying on evolved versions of tanks originally developed in the 1980s.

While main battle tanks have seen steady evolutionary development, the development of light tanks has been much more fractious and controversial. This has been due more to their mission than the technology. The last US Army light tank, the M41 Walker Bulldog, was developed in the late 1940s and was largely gone from US service by the early 1960s. It was mainly intended as a reconnaissance tank for the armored divisions and armored cavalry regiments. It was the last US tank to bear the official designation of "light tank," and during the final years of its career, it was renamed awkwardly as the "Tank, full-tracked, 76mm gun M41."

In place of the M41 came the radical M551 Sheridan, given the tongue-twisting designation of "Armored Reconnaissance Airborne Assault Vehicle." As its designation implied, it was intended to serve both in the traditional reconnaissance/cavalry role, and as an expeditionary tank for rapid intervention with airborne units. The Sheridan failed due to its problematic gun/missile system. Programs to replace the Sheridan stumbled for several decades, in part because the Army wasn't sure what it really wanted or needed. Was it primarily for the airborne/expeditionary role or for the mechanized cavalry? Or was it something very different, to provide direct fire support for the light infantry? The Army again insisted that such a weapon was not a "light tank" but an Armored Gun System, Mobile Protected Gun, Mobile Protected Weapon, or Mounted Combat System.

In the wake of the Cold War, the Army took a completely different approach, mounting a 105mm gun on the wheeled Stryker chassis as the M1128 Mobile Gun System. The Stryker MGS ignored the traditional airborne/cavalry role in favor of supporting light infantry in low-intensity conflicts such as those in Afghanistan and Iraq. It was seen as a weapon better suited to the "New World Disorder" and low-intensity conflicts around the globe. This controversial vehicle lasted a bit more than a decade before being prematurely retired in 2022. The reason was technological rather than tactical, centered on the wheeled vs. tracked debate. The latest venture into the light tank category, which the Army adamantly insists is not a tank, is the M10 Booker Mobile Protected Firepower. This is essentially an infantry support tank, intended to perform the same role as separate tank battalions and tank destroyer battalions in World War II.

The 2022 war in Ukraine again raised the controversy over whether "the tank is dead." Russian tank losses in this conflict have been exceptionally high, in part due to poor tactics and training, and in part due to new technology. One of the new technologies to have emerged is the FPV (First Person View) kamikaze drone that has been widely used by Ukrainian forces to decimate Russian armored vehicles. Yet the argument whether the kamikaze drone signals the death of the tank serves only to recall a similar debate a half-century ago with the first large-scale use of anti-tank guided missiles (ATGM) in the 1973 Yom Kippur War. The tank evolved to face the ATGM threat after 1973, and there is every reason to believe that counter-drone technologies will emerge over the next several years to face this novel threat.

GLOSSARY

AAI	Aircraft Armament Inc., Hunts Valley, Maryland (now part of Textron)
ABCT	armored brigade combat team
ACAV	armored cavalry vehicle
ACR	armored cavalry assault regiment
AGS	Armored Gun System
ACVT	Armored Combat Vehicle Technology
ALCO	American Locomotive Company, Schenectady, New York
AMC	Army Materiel Command
AOS	Add-On Stabilization
APC	armored personnel carrier
APC	armor-piercing, capped (projectile)
APCR	armor-piercing, composite rigid (projectile)
APCBC	APC with ballistic cap (projectile)
APFSDS	armor-piercing, fin-stabilized, discarding-sabot (projectile)
APS	active protection system
APU	auxiliary power unit
ARAAV	armored reconnaissance airborne assault vehicle
ARSV	armored reconnaissance scout vehicle
ARVN	Army of the Republic of (South) Vietnam
ASM	Armored Systems Modernization
ATACS	Advanced Tank Cannon System
ATGM	anti-tank guided missiles
AUSA	Association of the US Army

AVLB	Armored Vehicle Launched Bridge
BAE	British Aerospace, now BAE Systems
BCT	brigade combat team
BFT	Blue Force Tracking
BMY	Bowen & McLaughlin York, York, Pennsylvania, now part of BAE Systems
CATTB	Components Advanced Technology Test Bed
CBSS	Closed Breech Scavenging System
CIP	Combat Identification Panel
CITV	Commander's Independent Thermal Viewer
CROWS	Common Remotely Operated Weapon Station
CVWS	Combat Vehicle Weapon System
DARPA	Defense Advanced Research Projects Agency
DOT&E	Defense Operational Test and Evaluation
DMZ	Demilitarized Zone (Vietnam)
DVH	Double-V Hull
EAPU	External Auxiliary Power Units
ELKE	Elevated Kinetic Energy
ENSURE	Expedited Non-Standard Urgent Requirement for Equipment
FBCB2	Force XXI Battle Command Brigade and Below
FCS	Future Combat Systems
FY	Fiscal Year (e.g. FY90 = October 1, 1989 to September 30, 1990)
GDLS	General Dynamics Land Systems
GMC	General Motors Corporation
GPS	Global Positioning System

HBCT	heavy brigade combat team
HEAT	high explosive anti-tank (projectile)
HEP/HESH	high-explosive plastic/high-explosive, squash-head (projectile)
HIMAG	High Mobility Agility Test Vehicle
HSTV-L	High-Survivability Test Vehicle, Light
HVAP	high-velocity armor-piercing (projectile)
IBCT	infantry brigade combat team
JSMC	Joint Systems Manufacturing Center, formerly Lima Army Tank Plant
LAPES	low-altitude parachute-extraction system
LAV	light armored vehicle
LRIP	limited-rate-initial-production
LVAD	low-velocity air drop
LVT	Landing Vehicle Tracked
MCS	Mounted Combat System
MDAP	Mutual Defense Assistance Program
MERDC	Mobility Equipment Research and Design Command, Fort Belvoir, Virginia
MGS	Mobile Gun System
MGV	Manned Ground Vehicles
MPWS	Mobile Protected Weapon System
MPF	Mobile Protected Firepower
MPG	Mobile Protected Gun
MRM	Mid-Range Munition
NATO	North Atlantic Treaty Organization
NBC	nuclear, biological, chemical
NKPA	North Korean People's Army

NTC	National Training Center (Mojave Desert, California)
NVA	North Vietnamese Army
OIF	Operation *Iraqi Freedom*
OSD	Office of the Secretary of Defense
OTAC	Ordnance Tank and Automotive Command, became Army Tank-Automotive Center (ATAC) in 1962
PLA	(Chinese) People's Liberation Army
PLGR	Precision Lightweight GPS Receiver
RCV	Robotic Combat Vehicle
RDF	Rapid Deployment Force
RFGC	(Iraqi) Republican Forces Guards Corps
RISE	Reliability Improvement of Selected Equipment
ROK	Republic of Korea
RPG	rocket-propelled grenade
SACLOS	semi-automatic command line-of-sight
SAIC	Science Applications International Corporation
SEP	System Enhancement Program
SPAT	self-propelled anti-tank
SRV	Surrogate Research Vehicle
TACOM	Tank and Automotive Command, formerly OTAC and then ATAC prior to 1967; redesignated as Tank-Automotive and Armaments Command on October 1, 1994
TECOM	Test and Evaluation Command, Aberdeen Proving Ground, Maryland
TF	task force
TIGER	Total Integrated Engine Revitalization
TLAC	Top-Loading Air Cleaner
TRADOC	Training and Doctrine Command

TTB	Tank Test Bed
TTS	Tank Thermal Sight
TUSK	Tank Urban Survivability Kit
UN	United Nations
USAREUR	US Army Europe

FURTHER READING

This book is built around the numerous books written by the author for Osprey, primarily in the New Vanguard series. These are listed below. For readers interested in examining US tanks in the Cold War years from an international perspective, the three-part series *Tanks at the Iron Curtain* compares US development with efforts in NATO and the Warsaw Pact.

This book was based on a wide range of documents and books. I have omitted two categories of books from this bibliography. There is an extremely large selection of pictorial books aimed mainly at modelers, and I have omitted them largely for space reasons. Technical manuals are another valuable source on US tanks that I used when preparing this book, but once again, they are too numerous to list here.

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M24 Chaffee Light Tank 1944–1964 (2003)
M551 Sheridan: US Airborne Tanks 1942–2004 (2009)
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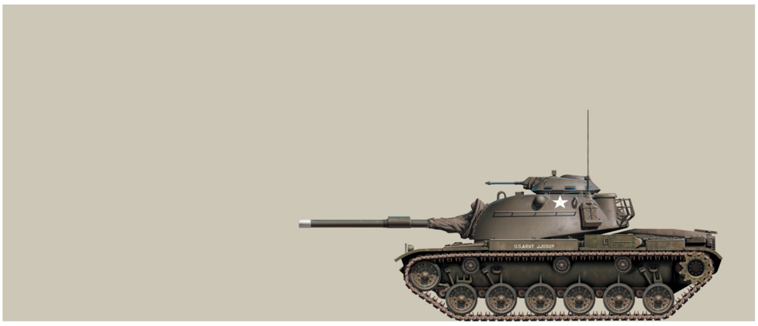

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